Annual Statistical Number

Engineering and Mining Journal

McGraw-Hill Co., Inc., New York

MINERAL LIBRARY
JAN 14 1918
UNIV. OF MICH.
LIBRARY

FOR EFFICIENCY

THE MODEL 8 "WAUGH" SHARPENER

ROCK WAUGH DRILLS

The highest efficiency in sharpening and shanking steel is only obtainable with the Model 8 "Waugh" Sharpener. It produces perfectly worked bits and shanks in the *shortest possible time* with the *minimum consumption of air.*

In addition to using less air at equal pressures than other machines, it will operate effectively on lower pressures than are required by machines of similar capacity.

This Sharpener not only saves in labor costs by greatly increasing the production of the blacksmith, but his ability to keep the drill runner supplied with plenty of properly sharpened steel not only increases the drilling speed, but avoids unnecessary strains on the working parts of the rock drill and helps to reduce the drill upkeep.

Bolts, pins, spikes, rivet heads and various other forms of forgings may be readily produced on this machine.

"Waugh" Sharpener at the Empire Copper Co.'s mine, Mackay, Idaho

THE Denver Rock Drill Manufacturing Co.

225 Rialto Bldg., San Francisco, Cal.
301 San Francisco St., El Paso, Texas
105-106 Maynard Bldg., Seattle, Wash.
393 Calle Carabaya, Lima, Peru
113 W. 2nd South St., Salt Lake City, Utah
Houghton, Mich. Joplin, Mo.
34 Queen St., Melbourne, Australia
30 Church St., New York City
51 W. Granite St., Butte, Mont.
401 Title Insurance Bldg., Los Angeles, Cal.
Royal Chambers, Johannesburg, So. Africa

CANADIAN ROCK DRILL COMPANY, LTD., Selling Agents:
42 Scott St., Toronto, Ont. Cobalt, Ont. 614 Baker St., Nelson, B. C. 912 Pender St., W., Vancouver, B. C.

E. 53

THE S-A METHODS

Published Weekly in the Interests of S-A Conveying Engineering

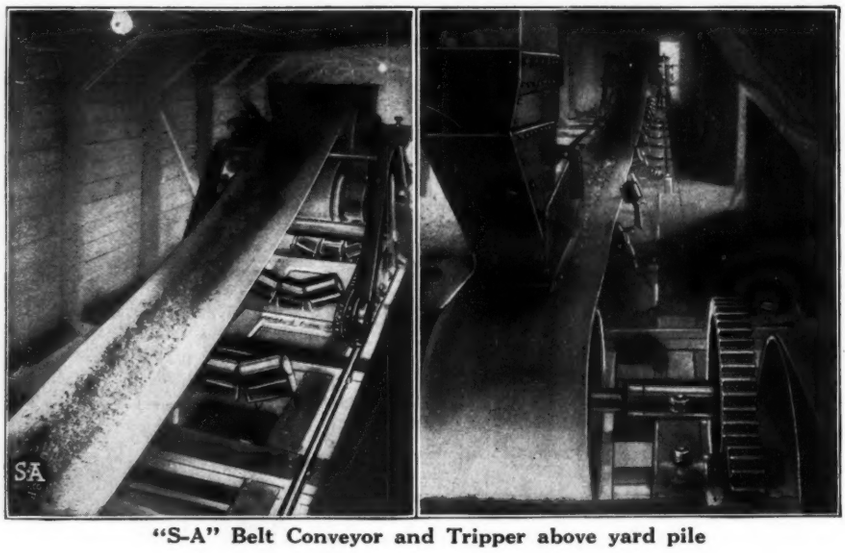
Solving the Labor Problem At a Big Saving in Quarrying

A large cement plant in northwestern New York put an end to its labor troubles at a big saving in its operating cost by installing an "S-A" Handling and Crushing Plant at its quarries.

The quarry operation consists of the usual drilling and blasting. The blasted rock is loaded by steam shovel to dump cars, which are hauled by steam locomotives to the crusher plant.

The cars dump directly into an "S-A" No. 9 Crusher, which delivers to a 30 x 12 x 15-in. "S-A" Heavy Bucket Elevator, discharging to an elevated hopper. The second reduction is obtained in an "S-A" No. 7 Gyratory Crusher, to which the rock is fed through an "S-A" Rotary Grizzly Feeder. The latter by-passes the undersize and relieves the crusher from needless work. The crushed rock is then elevated by 20 x 9 x 12-in. "S-A" Continuous Bucket Elevator, discharging into a 20-in. x 66-ft. "S-A" Belt Conveyor, supported in a 19-ft. timber trestle and from which a removable tripper spouts the material to the ground storage pile. From the latter it is transported to the mill on a 2000-ft. cable train.

Thus this company changed the personnel of its labor from a large number of unskilled men to a few skilled operators at a decided saving in its payroll.



"S-A" Belt Conveyor and Tripper above yard pile

The "S-A" Engineers

will gladly assist you in laying out new crushing and conveying plants or in modernizing your present one. Consult them on any problem regarding the efficient handling and storing of bulk material.

Write for Catalog.

Stephens-Adamson Mfg. Company, Aurora, Illinois

Conveying, Screening, Transmission Machinery

Branch Offices

50 Church St., NEW YORK
First National Bank Bldg., CHICAGO
79 Milk St., BOSTON, MASS.
H. W. Oliver Building, PITTSBURGH
803 Federal Bank Bldg., ST. LOUIS, MO.
1st Natl. Bank Bldg., HUNTINGTON, W. VA.
824 Dime Bank Bldg., DETROIT, MICH.
310 Stair Bldg., TORONTO, CANADA
412 East Third St., LOS ANGELES
503 Dooly Block, SALT LAKE CITY

Australian Agent—Arthur Leplastrier & Co., Circular Quay East, Sydney
South African Agent—J. Mac G. Love & Co., Lim ted, 1 and 3 London House, Loveday St., Johannesburg.
C. S. Christensen A-S, Post-Box 85, Kristiania, Norway.

Engineering and Mining Journal

January 12, 1918

Volume 105 *Number* 2

The production of the more important metals is summarized in the table on this page. The details appear on subsequent pages. It will be found that in some cases our contributors give figures that do not agree with our own. The explanation of such differences will generally be that the articles of outside contributors were necessarily written and put into type before our own statistics were available. The necessity of handling the great mass of material in this huge number in a few days leaves no time for leisurely comparison and revision to effect a careful coördination of all the data.

PRODUCTION OF METALS IN THE UNITED STATES

Metal	Unit	1915	1916	1917
Copper (*a*)	Pounds	1,423,698,160	1,942,776,309	1,888,395,945
Gold (*b*)	Dollars	101,035,700	92,590,300	84,456,600
Iron	Long tons	29,916,213	39,434,797	38,367,853
Lead (*c*)	Short tons	535,922	592,241	580,464
Nickel (*e*)	Pounds	56,352,582	72,611,492	56,807,613
Silver (*b*)	Troy ounces	67,485,600	74,414,802	74,244,500
Zinc (*d*)	Short tons	507,142	680,018	685,436

(*a*) Production from ore originating in the United States. (*b*) The statistics for 1915 and 1916 are the final and those for 1917 are the preliminary statistics reported jointly by the directors of the Mint and the U. S. Geological Survey. (*c*) Production of refined lead from ore and scrap originating in the United States; antimonial lead is included. (*d*) Total production of smelters, except those treating dross and junk exclusively; includes spelter derived from imported ore. (*e*) Imports; for 1917, first 9 months only. This nickel is refined in the United States for the production of metal, oxide and salts.

Owing to the congestion of material for this number, we found ourselves obliged to omit the usual table of dividends paid by mining companies. This will be published in the issue of next week.

The preëmption of this issue by matter of statistical and review character excludes many things of timely interest that ought to be covered. Among these are the introduction in Congress of a bill for Federal control of the mining industry. We shall discuss this next week. Also we shall then publish biographical sketches of A. A. Blow, a distinguished mining engineer, and Lieut. William Hague, whose deaths we have to report regretfully this week. Some generous contributions to our fund for the 27th Engineers have been received, but acknowledgment of these must also be postponed.

In 1913 we were able to give at this time figures of the world's production of copper, gold, spelter and tin in the year that had closed a few days previously. These figures were not mere guesses, but were based on official reports covering 10 or 11 months of the year, with estimates only for November and December. When the final figures were published several months later, they were found to vary from our preliminary figures by only a trifling percentage. The statistics that we are able to present this year, as was also the case a year ago, are far more incomplete that in 1913 and previous years, thus reflecting the disturbances created by the war, which has put many commercial conditions out of joint.

The world's production of gold in 1917 is estimated at $430,000,000, compared with $457,006,045 in 1916.

The world's production of copper in 1917 was 1,413,056 metric tons, against 1,406,353 metric tons in 1916.

The United States production of petroleum in 1917 is estimated by the United States Geological Survey at 341,800,000 bbl., against 300,767,158 bbl. in 1916.

Bituminous coal production in the United States is estimated by the United States Geological Survey at 544,142,000 short tons, against 505,519,682 tons in the previous year.

Although both the productions of lead and zinc were the largest on record, each of these industries was in a state of depression at the end of 1917, the increases having been made in the early part of the year.

To all the contributors who collaborated in this number we tender our thanks, and also to the many persons who have assisted in the collection of statistical information. Our thanks are due also to the producers of copper, lead, spelter and other substances, who have communicated to us the amount of their output in 1917 and have thereby enabled a close approximation to the actual production in 1917 to be made by Jan. 9, 1918, our time of going to press.

As is always the case, the matter that ought to go in this Annual Review Number exceeds the limits of its pages. Consequently a good many interesting and valuable reviews must be deferred for publication in the next following issue. Indeed, by force of circumstances, the issue following the Annual Review Number is becoming something of a supplement. We recommend our readers who preserve separately, for reference during the year, this Annual Review Number, to attach to it the next following number.

In view of the fact that the *Journal* goes to press three days before its nominal date of publication, we were unable to make the first number of 1918 the Annual Statistical Number, as usual, for there would have been only one day after the close of 1917 in which to tie up the hundreds of loose ends. About the middle of 1917 we decided that the next statistical number would have to be the second issue of the new year. This decision proved to be fortunate, for the delays in mail service at the year-end were such that the necessary information could not possibly have been obtained in time for the first issue.

Metal Markets

NEW YORK—Jan. 9, 1918

The chief features in the metal market this week were the further advance in the price for lead and the renewed and startling advance in the price for tin, the supply of which continues as scanty as heretofore.

Copper—The present troubles of refiners are chiefly the embargoes on transportation, especially that which results from the congestion on the railways, besides which there has lately been serious trouble from ice in the harbor.

Another thing that is annoying producers is the delay in payment by the Government for the copper that they are supplying. This is due solely to the demon of red tape. The War Department is the offender. Relations with the Navy Department are quite satisfactory.

Copper Sheets are quoted at 31½c. per lb., f.o.b. mill, for hot rolled, and 1c. higher for cold rolled. Copper wire is quoted at 26@27c. f.o.b. mill, carload lots.

SILVER AND STERLING EXCHANGE

Jan.	Sterling Exchange	Silver New York, Cents	Silver London, Pence	Jan.	Sterling Exchange	Silver New York, Cents	Silver London, Pence
3	4.7515	87⅛	43⅝	7	4.7515	90⅛	45⅛
4	4.7515	89⅛	44⅝	8	4.7515	90⅛	45⅛
5	4.7515	90⅛	45⅛	9	4.7515	90⅛	45⅛

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine.

DAILY PRICES OF METALS IN NEW YORK

Jan.	Copper Electrolytic	Tin Spot.	Lead N. Y.	Lead St. L.	Zinc St. L.
3	*23½	†77	6⅛ @6⅜	6.35 @6.40	7⅛
4	*23½	†80	6.50 @6.70	6.45 @6.50	7⅛
5	*23½	†80	6.50 @6.70	6.45 @6.50	7⅛
7	*23½	†81	6.50 @6½	6.50 @6.55	7⅛
8	*23½	†82	6½ @6½	6.50 @6.55	7⅛
9	*23½	†85	6½ @6½	6.50 @6.55	7⅛ @7⅜

† Nominal.

* Price fixed by agreement between American copper producers and the U. S. Government, according to official statement for publication on Friday, September 21, 1917.

The above quotations (except as to copper, the price for which has been fixed by agreement between American copper producers and the U. S. Government, wherein there is no free market) are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for the deliveries constituting the major markets, reduced to basis of New York, cash, except where St. Louis is the normal basing point.

The quotations for electrolytic copper are for cakes, ingots and wirebars.

We quote electrolytic cathodes at 0.05 to 0.10c. below the price of wirebars, cakes and ingots.

Quotations for spelter are for ordinary Prime Western brands. We quote New York price at 17.5c. per 100 lb. above St. Louis.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1 cents.

LONDON

Jan.	Copper Standard Spot	Copper Standard 3 Mos.	Copper Electrolytic	Tin Spot	Tin 3 Mos.	Lead Spot	Zinc Spot
3	110	110	125	271½	263	29½	54
4	110	110	125	280	273	29½	54
5							
7	110	110	125	281	274	29½	54
8	110	110	125	289	284	29½	54
9	110	110	125	300	295	29½	54

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2,240 lb. For convenience in comparison of London prices, in pounds sterling per 2,240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at $4.7515. £30½ = 6.4696c.; £54 = 11.4545c.; £120 = 25.4544c.; £137 = 29.0605c.; £240 = 50.9089c. Variations, £1 = 0.2121205c.

Tin—In the London market this week tin rose £31. This is reflected in our quotations, which, however, are nothing more than nominal.

Lead—At the beginning of the week the A. S. & R. Co. advanced its price to 6½c. New York, but in so doing it was only coming up to the market that had already been established. There was an increased inquiry and a considerably larger volume of business than in the previous week, and by Jan. 7 the market was showing further strength. The statistical position has become very strong, for not only have stocks in the hands of producers been absorbed, but also the principal producers have pretty well sold out their books up to the end of February, of course making such reservations as the Government is expected to require. The present strength of the lead market without any doubt reflects the curtailment of production in the last quarter of 1918.

Zinc—This market was very dull. Some small sales were made from day to day at 7⅛c., but on Jan. 8 producers who had already sold at that price and desired to sell more were unable to get it, and on Jan. 9 there were reports of offerings at 7⅛ cents.

Zinc Sheets—Price of zinc sheets has not been changed. Market is still at $19 per 100 lb. f.o.b. Peru, less 8% discount.

Other Metals

Aluminum—This market continues comparatively inactive at 37@38c. per lb. for No. 1 ingots at New York, though some advances are being asked for spot delivery owing to railroad congestion.

Antimony—Unchanged at 14½c. for spot, and 13½c. for futures, c.i.f., in bond. Some houses think that they can discern a little stronger tendency.

Bismuth—Officially unchanged at $3.50 per lb., but some impure metal from South America is being sold under the price of the standard metal.

Cadmium—This metal is quoted at $1.50 @2.00 per lb., depending on the quantity.

Nickel—Steady at 50c. per lb., premium of 5c. per lb. for electrolytic.

Quicksilver—Quicksilver to arrive was still quoted at $115 and spot at $125. Small business was done in spot at prices around $130. San Francisco reports, by telegraph, $112.50.

Gold, Silver and Platinum

Silver—The market has been steady for several days at 45⅛d. in London and at 90⅛c. in New York. Shipments to London have been delayed owing to the embarrassments of shipping facilities. San Francisco has not been a very keen bidder lately, owing to slightly easier Eastern exchanges.

Mexican dollars at New York: Jan. 3, 70⅛c.; 4, 72c.; 5, 73c.; 7, 73c.; 8, 73c.; 9, 73c.

Platinum—Strong at $105.

Palladium—Sales at $135.

Zinc and Lead Ore Markets

Joplin, Mo., Jan. 5—Blende, per ton, high $72.40; basis 60% Zn, premium $70; medium to low, $60@50; calamine, per ton, 40% Zn, $38@31; average selling price, all grades of zinc, $55.80 per ton.

Lead, high $81.70; basis 80% Pb, $83@80; average selling price, all grades of leed, $68.40 per ton, the bulk of the shipment being of low grade.

Shipment the week: Blende, 9607 tons, calamine, 418 tons, lead 913 tons. Value, all ores the week, $626,450.

Other Ores

Manganese Ore—Metallurgical ore was unchanged at $1.20 per unit.

Molybdenum Ore—Business was done at $2.25@2.30 per lb. of molybdenum sulphide, basis 90 per cent.

Iron Ore—Without any formal opening, contracts for Lake Superior iron ore for the 1918 season are now being concluded, the set prices for iron and steel generally having been reaffirmed at Washington to Mar. 31. The ore prices are a continuance of the 1917 season schedule, originally announced Nov. 23, 1916: Old range bessemer, $5.95; nonbessemer, $5.20; Mesabi bessemer, $5.70; nonbessemer, $5.05; at Lake Erie dock. Contracts carry a proviso that the price is to be revised according to any change subsequently made.

Pyrites—Spanish lump is quoted at 15½c. per unit, on basis of 10s. ocean freight, buyer to pay excess freight and war risk, except that concession of 2% of war risk is allowed. Ocean rates remain at 35s. for Northern, 40s. for Southern and 42s. 6d. for Gulf ports, but recent charters have exceeded these rates in several instances.

Tungsten Ore—Business was mainly in ore of moderate grade, for which $22 was quoted. Low-grade ore was quoted at $19, and very high-grade, at about $24,50. Scheelite was quoted at $26.

Iron Trade Review

PITTSBURGH—Jan. 8

The iron and steel market is very narrow as regards ordinary commercial transactions. On the whole there is scarcely any inquiry, and offerings are equally light. Consumers are evidently in no mood to buy, and are believed to have fair stocks on hand, which in the circumstances they would prefer to reduce; as they feel confident prices will not be advanced, and may be reduced Mar. 31. Producers are making no effort to force the market, both because they know buyers would take hold of their own accord if they were ready, and because production is so uncertain that delivery engagements would stand little chance of being kept. Inventory and other year-end adjustments are particularly complicated at this time and office forces are kept particularly busy, being short-handed, this furnishing another cause for market quietness.

Irrespective of these conditions, however, there is no likelihood of any broad buying under the set-price policy. There is a very large volume of contract business still to be filled, and thereafter the tendency will be to do business on a hand-to-mouth basis.

The Pennsylvania and Baltimore & Ohio have declared general embargoes against the receipt of all freight, except raw materials for the blast furnaces and steel plants, and perishable goods. The measures are not fully understood yet, but if kept in force would greatly curtail shipments from the mills, and they are assumed to be only temporary. There has been a slight loosening up in some of the blockades on various divisions, and coal and coke are moving a trifle more freely. Production of both pig iron and steel continues at a reduced rate, many furnaces being banked.

Pig Iron—The market is quite devoid of transactions. Messrs. W. P. Snyder & Co. announced their usual monthly averages, compiled for many years from actual market sales, but admitted that the market sales were almost negligible in tonnage. Last October, the first month of the set prices, the volume was the largest since June. The December averages were precisely the set prices, $33 for basic and $36.30 for Bessemer, at valley furnaces. The market remains quotable at $33 for basic and No. 2 foundry, $36.30 for Bessemer, $33.50 for malleable and $32 for forge, f.o.b. furnace, freight from the valleys to Pittsburgh being 95c.

Steel—There are no offerings of regular soft-steel billets or sheet bars, set prices for which are $47.50 and $51 respectively. There continue to be free offerings of discard steel in various billet sizes, at about $2.50 below the set prices for soft steel, but there is only a moderate demand for this material.

Ferroalloys

Ferromanganese—Without any particular cause being apparent and indeed in a dull market, ferromanganese has stiffened and the usual quotation is $250, against $245 for several weeks.

Coke

Connellsville—Car supplies in the coke region were much better Monday of this week, with fair promise for the balance of the week, and some of the congestion of loaded cars at yards and on sidings has been eliminated, but receipts at furnaces show no more than a slight improvement and many stacks are still banked. There are no offerings in the open market but some are expected if production reaches anything like a normal rate. A meeting was held at Uniontown last Thursday between Warren S. Blauvelt, national coke administrator, and the operators of the region, about 200 being present. The operators asked for more transportation facilities. A committee of seven was appointed, this committee to appoint an executive committee of three to act directly with the Fuel Administration. Set prices remain at $6 for furnace, $7 for 72-hour selected foundry and $7.30 for crushed, per net ton at ovens.

Gold and Silver

RELIABLE estimates of gold production in 1917 have been difficult to get thus soon after the close of the year, owing to the disturbed conditions prevailing. According to the best data obtainable, the gold output of the world in 1917 was about $430,000,000 or approximately 6% less than the 1916 output, which was $457,006,045. In general, the peculiar economic situation existing in the gold-mining industry tended to discourage production. Cost of labor and supplies mounted steadily, though the value of gold was unchanged. The total production of the United States in 1917 is estimated at $84,456,600 ($92,590,300 in 1916), of which $83,052,500 came from continental United States; Philippine Islands contributed $1,404,000 and Porto Rico a very small amount. California led the gold producing sections of the country with $20,815,900 in 1917 against $21,980,400 in 1916. Colorado, which produced $19,185,000 in 1916, held on to second place in 1917, though its output fell to $15,955,100. Alaska again ranked third with $15,170,300 in 1917, compared with $16,124,800 in 1916.

TABLE I. GOLD PRODUCTION OF THE WORLD FOR 20 YEARS

1898	$287,327,833	1908	$443,434,527
1899	311,505,947	1909	459,927,482
1900	258,829,703	1910	454,213,649
1901	260,877,429	1911	459,377,300
1902	298,812,493	1912	474,333,268
1903	329,475,401	1913	462,669,658
1904	349,088,293	1914	451,582,129
1905	378,411,054	1915	473,124,590
1906	405,551,022	1916	457,006,045
1907	411,294,458	1917 (estimated)	430,000,000

Silver production of the United States in 1917 was 74,244,500 oz. against 74,414,802 oz. in 1916. Of the 1917 output, 74,227,900 oz. came from continental United States and 16,600 oz. from Philippine Islands. The leading silver producing states in 1917 were Utah, Montana, Idaho and Nevada, in the order named, with respective productions of 14,315,300 oz., 13,711,100 oz., 11,683,100 oz. and 11,441,000 ounces. These states also led in 1916 in silver production.

GOLD AND SILVER PRODUCTION OF THE UNITED STATES (*a*)

(Gold, Value; Silver, Fine Ounces)

	Gold		Silver	
	1916	1917	1916	1917
Alabama	$7,400	$4,200		
Alaska	16,124,800	15,171,300	1,266,317	1,351,100
Arizona	4,092,800	5,533,800	6,680,252	8,183,200
California	21,980,400	20,815,900	1,936,910	1,989,800
Colorado	19,185,000	15,955,100	7,551,761	8,163,600
Georgia	20,400	6,000		
Idaho	1,058,300	711,500	11,570,399	11,683,100
Illinois			5,782	3,300
Maryland		100	153	1,100
Michigan			759,068	686,700
Missouri			128,860	21,100
Montana	4,328,400	3,756,500	14,046,054	13,711,100
Nevada	9,064,700	6,922,900	13,682,067	11,441,000
New Hampshire			935	
New Mexico	1,350,000	1,025,100	1,729,917	1,313,700
North Carolina	23,000	15,700	1,738	2,800
Oklahoma			606	
Oregon	1,901,500	1,677,400	221,887	215,700
South Carolina	300	1,100		
South Dakota	7,471,700	7,392,600	210,100	191,100
Tennessee	5,700	5,300	93,837	99,300
Texas	500	900	664,319	583,200
Utah	3,859,000	3,620,300	13,545,802	14,315,300
Vermont	300		1,964	400
Virginia	500	1,700	508	9,400
Washington	580,600	434,900	294,516	257,000
Wyoming	20,200	200	3,407	4,900
Continental U. S.	$91,075,500	$83,052,500	74,397,159	74,227,900
Philippines	1,514,200	1,404,000	17,643	16,600
Porto Rico	600	100		
Totals	$92,590,300	$84,456,600	74,414,802	74,244,500

(*a*) As reported by the Directors of the United States Mint and the Geological Survey.

Silver in 1917

BY EDWARD BRUSH*

AT THIS writing, it is impossible to do better than to guess as to the production of silver during 1917, either for the United States or for the world. It is possible, however, to make a close approximation as to this production.

The Director of the Mint reports the production in the United States during 1916 as about 74,500,000 oz., which was derived nearly equally from siliceous ores, lead ores and copper ores. The production from lead ores was slightly in excess of that derived from either of the other sources.

It appears, also, that this production varied only in an unimportant amount for the first three years of the war—1914, 1915 and 1916. Previous to these years, the yearly production of the United States varied, but not in a progressive ratio, between 50,000,000 oz. and 60,000,000 oz. since 1889, or a period of 25 years.

Undoubtedly the increased production since the beginning of the war was due entirely to the increased prices of lead and copper in this period. During the first six months of 1917, prices were still further enhanced, and during the latter half of the year the production of both lead and copper was considerably restricted, due to varying causes.

From the above, it would seem safe to assume a somewhat lessened production from lead and copper ores, which probably was offset by an increased production from siliceous ores, due to the constantly increasing price of silver for the first nine months of the year. From another angle, it may be concluded that there was no material change in the amount of silver produced in the United States during 1917, as compared with 1916.

MONTHLY AVERAGE PRICE OF SILVER (*b*)

Month	New York			London		
	1915	1916	1917	1915	1916	1917
January	48.855	56.775	75.630	22.731	26.960	36.682
February	48.477	56.755	77.585	22.753	26.975	37.742
March	50.241	57.935	73.861	23.708	27.597	36.410
April	50.250	64.415	73.875	23.709	30.662	36.963
May	49.915	74.269	74.745	23.570	35.477	37.940
June	49.034	65.024	76.971	23.267	31.060	39.065
July	47.519	62.940	79.010	22.597	30.000	40.110
August	47.163	66.083	85.407	22.780	31.498	43.418
September	48.680	68.515	100.740	23.591	32.584	50.920
October	49.385	67.855	87.332	23.925	32.361	44.324
November	51.714	71.604	85.891	25.094	34.192	43.584
December	54.971	75.765	85.960	26.373	36.410	43.052
Year	49.684	65.661	81.417	23.675	31.315	40.851

New York quotations, cents per ounce troy, fine silver; London, pence per ounce sterling silver, 0.925 fine.

(*b*) Engineering and Mining Journal prices.

The statistics as to imports and exports of silver issued by the Department of Commerce indicate that the imports for the first eight months of 1917 were approximately 3,000,000 oz. in excess of the imports for the same eight months of 1916. On the other hand, the exports increased about 3,500,000 oz., leaving by de-

*Vice president, American Smelting and Refining Co., 120 Broadway, New York.

duction the amount produced in this country unchanged, unless the consumption in the arts and for coinage was materially different, which is not probable. I can find nothing which leads me to believe, therefore, that the production of silver in the United States during 1917 differed to any considerable extent from that of 1916, viz., something less than 75,000,000 ounces.

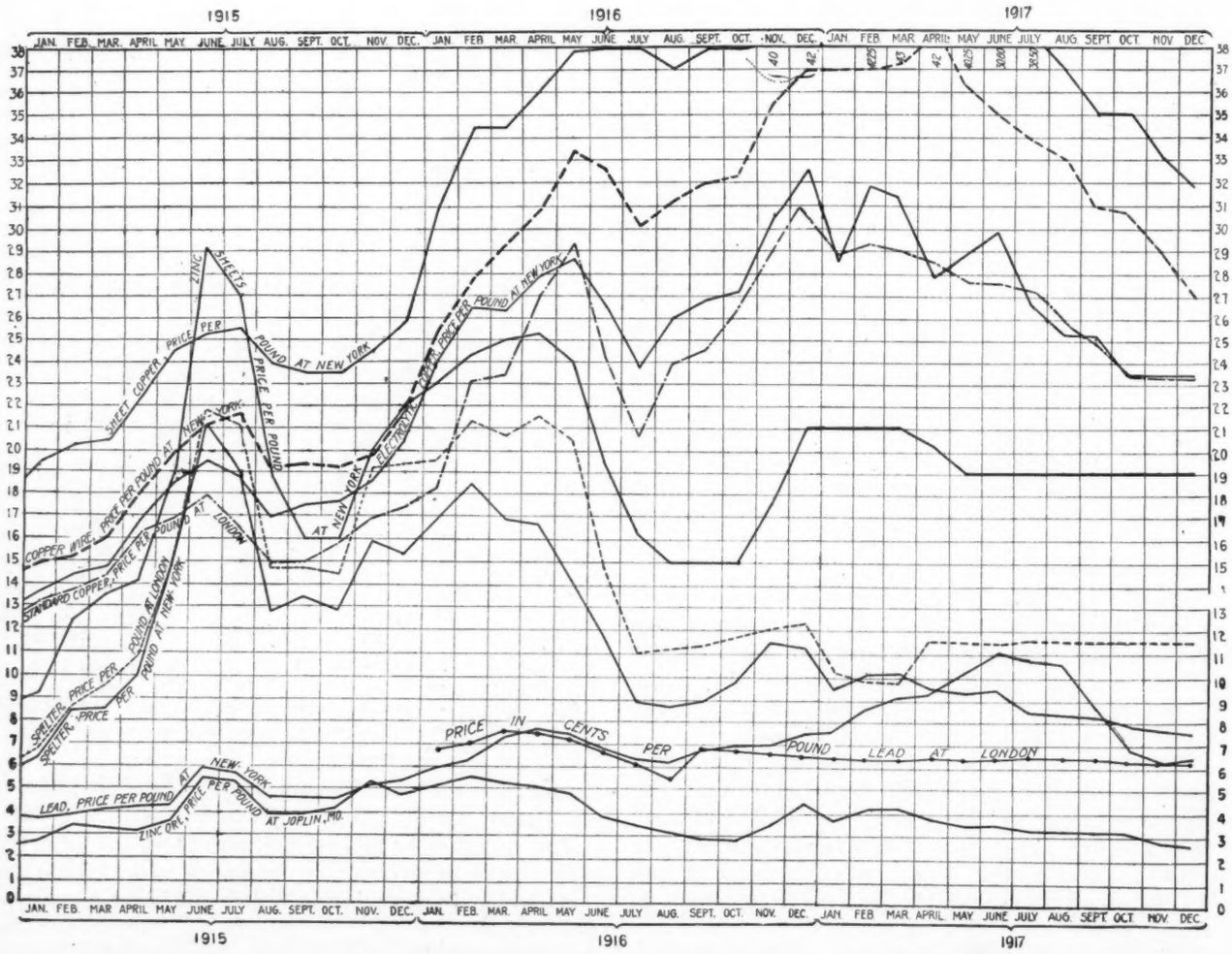
As to the world's production, the Director of the Mint reported 180,000,000 oz. for 1915, and 157,000,000 for 1916. Of this decline of 23,000,000 oz., Mexico alone was responsible for 17,000,000 oz. The import statistics referred to above show an increase during the first eight months of 3,000,000 oz., which applied to the year will probably equal about 5,000,000 oz., derived almost entirely from Mexico. It would seem safe to assume, therefore, that the production of the world, outside of the United States, increased 10,000,000 oz., making the production for 1917, 167,000,000 ounces.

Silver Market Stationary Until Mid-Year, When Eastern Demand Stimulated Prices

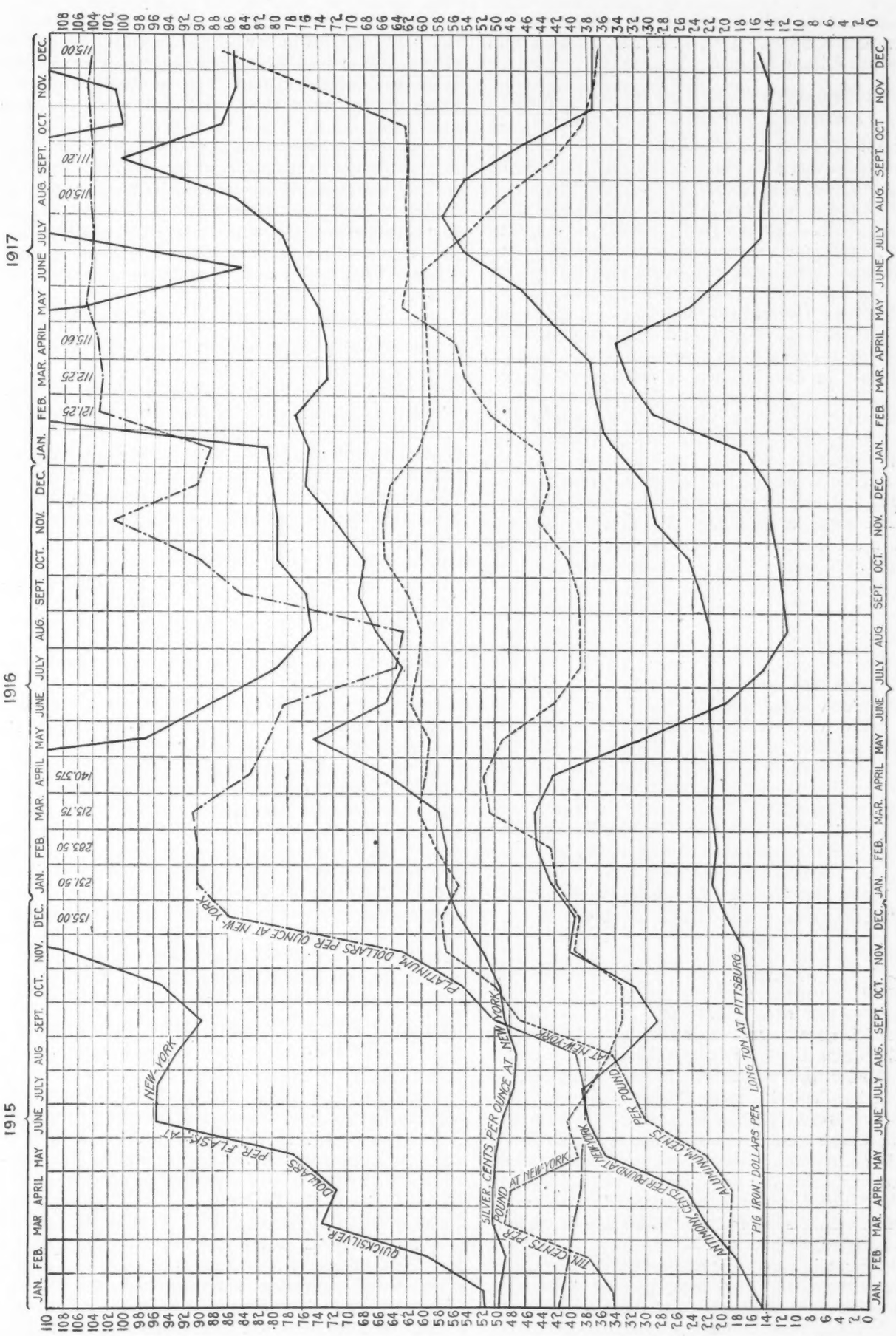
While there was nothing unusual during the year 1917 in the production of silver, the situation as to demand was entirely unprecedented, both as to amount and direction. This demand had a decided effect on prices, which have not been equalled for 40 years. On account of Governmental control, the full natural effect, however, was not permitted, which will be referred to later.

The silver market began to feel the effect of war demand in April, 1916, when the quotation of 73½c. was made, against 60¾c., the highest in the preceding month. In May, 1916, the average price was about 74¼c., and except for a brief period of recession in the summer of 1916, the level of prices remained nearly stationary around 75c. per oz. until June, 1917. From average monthly price tables, it may be noted that the quotations for May, 1917, were not materially higher than those made during May, 1916.

During May and June purchases were made by London brokers for India and China, for shipment from the Pacific Coast, at sufficiently higher prices than the New York market to warrant diverting the silver production usually forwarded to London via New York. In July a sale was made of 5,000,000 oz. to the Russian government, for shipment to Vladivostok, and at about the same time the prospects as to India crops became very encouraging, both as to amount, value and demand. The question became one of world-wide interest as to how the balance of trade in favor of India was to be paid. Under normal circumstances, the India banks were given their choice as to gold or silver. There was a certain demand for silver on the part of the government for rupee coinage, and by the bazaars for shipment into the interior, in payment for produce, and to be hoarded by the natives. After these insistent demands for silver had been satisfied, it had been the policy for many years,


1915
1916
1917
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
SHEET COPPER, PRICE PER POUND AT NEW YORK
ZINC SHEETS, PRICE PER POUND AT NEW YORK
COPPER WIRE, PRICE PER POUND AT NEW YORK
STANDARD COPPER, PRICE PER POUND AT LONDON
ELECTROLYTIC COPPER, PRICE PER POUND AT NEW YORK
SILVER, BRITISH PRICE PER OUNCE STERLING
SILVER, NEW YORK PRICE PER OUNCE
SPELTER, PRICE PER POUND AT NEW YORK
SPELTER, PRICE PER POUND AT LONDON
LEAD, PRICE PER POUND AT NEW YORK
ZINC ORE, PRICE PER POUND AT JOPLIN, MO.
PRICE IN CENTS PER POUND LEAD AT LONDON

MONTHLY PRICE AVERAGES OF BASE METALS AND THEIR MANUFACTURES—1915, 1916 AND 1917


1915
1916
1917
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
PLATINUM, DOLLARS PER OUNCE AT NEW-YORK
QUICKSILVER, DOLLARS PER FLASK, AT NEW-YORK
SILVER, CENTS PER OUNCE AT NEW YORK
TIN, CENTS PER POUND AT NEW YORK
COPPER, CENTS PER POUND AT NEW YORK
ANTIMONY, CENTS PER POUND AT NEW YORK
ALUMINUM, CENTS PER POUND AT PITTSBURG
PIG IRON, DOLLARS PER LONG TON AT PITTSBURG

MONTHLY AVERAGES OF METAL PRICES IN 1915, 1916 AND 1917

on the part of the British government, to discourage the importation of silver. This, of course, materially increased the demand for gold.

Silver Situation in the East in Large Degree Responsible for Advance in Price

For the 10 years preceding 1898 the absorption of gold in India was $135,000,000. During the following 10 years it was $440,000,000, and for the three years preceding the present war it averaged $150,000,000, or about one-half of all the gold produced in the world which is free for coinage or bank reserves. Great Britain soon found after war began that her gold reserve was her most important line of defense. The United States Government, notwithstanding its immense importations of gold, is now not willing to export any of it, except as an absolute necessity, which is passed upon in each instance by the Federal Reserve Board. There is little wonder, therefore, that Great Britain, some time since, prohibited the shipment of gold to India, and also used its great influence to discourage shipments to China. This threw on silver the entire burden of paying the balance of trade in favor of India, and, due to good crops and increased prices, this balance was much greater than usual. Under this stimulus, the average quotations for July, August and September are shown in the accompanying table:

SILVER PRICES IN THIRD QUARTER OF 1917

	New York Cents	London Pence
July	79.010	40.110
August	85.407	43.418
September	100.740	50.920

During September the highest quotation was $1.08½ in New York, and 55 pence in London.

The danger of these high prices to the domestic and financial condition of India was due to the fact that the silver in the rupee became of greater value than the gold redemption value of the rupee, which would naturally lead to the melting of the coins in circulation, leaving India without a currency. It became necessary, therefore, for the India Council to promulgate decrees making it a penal offense to melt the rupee, or to export silver. Later they forbade all importation of silver, except such as was made by the India government itself. The British government also again used its influence with the China banks to induce them to stop buying silver. Under these influences, the silver quotations declined during the last quarter of the year.

SILVER PRICES FOR FOURTH QUARTER OF 1917

	New York Cents	London Pence
October	87.332	44.324
November	85.891	43.584
December 1 to 18	85.583	42.899

The commercial situation in India, and also presumably in China, has not been met, however, but simply the amount of silver which the various governments and the arts are purchasing has been purchased at a figure less than the September maximum, and either the exportations of merchandise from India, China and Japan have been restricted, or have not been paid for. Some of this commerce is most seriously needed by the United States and the other Allies, to say nothing of the stagnation which must be the result of these governmental actions in India. Gold will not be spared by any nation, except as a last resort. Silver cannot be shipped to India except as purchased by the India government, but an amount of free silver has not been produced and does not exist sufficient to pay, at the present price of 88c. per oz., even a small proportion of the balance of trade in favor of India and China, if the produce and supplies come forward which the United States and the Allies sadly need.

Good authorities conversant with the exchange situation have given their opinion to the effect that as much as 200,000,000 oz. of silver could be used to pay for needed or past importations from India, China and Japan, in excess of the normal production of silver during the first half of the year 1918. The question which arises is as to where such an amount of silver can be obtained.

Securing the Great Supply of Silver Needed

The economist would say, doubtless, that the price of silver should be enhanced up to the point of bringing about the necessary production. One difficulty with this general rule, as applied to silver production, is that less than one-third of the production of silver is received from strictly silver mines. Considerably more than two-thirds of the silver is produced either from mines producing lead and copper, or from mines shipping their siliceous ores to lead and copper smelters. If the silver production should be stimulated from such mines, it would also very largely increase the production of lead and copper, which might possibly depress the prices of these metals to an extent which would more than offset the advantage to the mines of an increased price of silver. It is supposed that the strictly siliceous mines produced in the United States this year something less than 25,000,000 oz. Probably even a greatly enhanced price for silver could not, during the next six months, increase this production more than 20%, or, say, 5,000,000 oz. This increase, therefore, goes a very small way toward a needed supply of 200,000,000 ounces.

The only source of supply of spot silver in any quantity is the silver dollars held in the United States Treasury as security against the circulation of silver certificates. The subject is being very seriously considered on the part of various governmental departments, on account of the war needs in connection with India products, whether proper legislation can be obtained whereby the temporary use of this silver in dollar coins can be authorized, the silver to be returned through government purchases at a maximum price which it is expected will make possible an increased production of silver.

Important Silver Shipments Made Direct to the East Instead of "Through London"

The usual flow of silver via New York to London, and from London to India and China has been interfered with markedly during the last half of 1917 by the high cost of transportation from both New York to London and from London to India. This has resulted in diverting a large proportion of the production of silver in the United States to the Pacific Coast, for shipment from Pacific ports to India and China. At first, the London brokers made great effort to continue to purchase in New York, shipments to be made at their option. Large governmental purchases, however, made for Russia, China and the India governments broke the hold of the London brokers, and silver was largely sold in unusual quantities for shipment over considerable periods of time. It is known that, during the last half of the year,

seven separate sales transactions covered as large a quantity as 20,000,000 oz. This left the New York market in great uncertainty. There were periods of weeks at a time when there was no market for silver excepting London, and yet there was no considerable supply of silver for shipment to London. This resulted in the New York market being obliged to ignore the demand via San Francisco in the daily market quotations.

India was able to secure approximately 40,000,000 oz. of sycee silver from China and about 15,000,000 Philippine coined dollars (which had been held in the Philippine treasury for many years), before the full advance in prices registered during the fall months. The demand for rupees, however, was so great that new coinage took place during the year to the number of 207,737,326, against only 16,000,000 in the previous year.

Resumption of London Domination Probable After the War

Since, normally, at least three-quarters of all the silver consumed in the world is consumed in India and China, it would seem that San Francisco was a more centrally dominating market for silver than either New York or London, and should any disparity in shipping costs continue after the war, this might be one of the results of the war's disturbance. But any disparity in shipping costs which may prevail after the war will probably be overcome by the control of Eastern exchange, which is held in London, and it does not seem reasonable to expect, therefore, that anything will interfere with the resumption of London domination of silver values after the present war disturbance is over.

The notable events of the year in the silver market have been: (1) the highest price in 40 years; (2) the enormous coinage of rupees; (3) the unusually large purchases by India from China and the Philippines; (4) the large purchases by Russia and (5) the diversion of the usual flow of silver through New York to an equal exportation through San Francisco. The year 1918 may have even more strange events in store for the silver market.

Platinum

At the beginning of 1917, the supply of platinum in the United States was fairly plentiful though Russian production was still much below that of the pre-war period. The Russian government had taken over the output of the mines through the agency of the State Bank in November, 1916. The Russian revolution thoroughly demoralized the industry, the peasants in several instances driving the managers of the estates away and attempting to work the mines themselves. According to J. P. Hutchins, an engineer who recently returned from Russia, the output of platinum from the Urals was estimated by Russian authorities at 100,000 troy oz. in 1917, with the production for the preceding war years as follows: 166,778 oz. in 1916, 113,090 oz. in 1915 and 155,838 oz. in 1914. The 1917 output of Colombia is estimated at 30,000 troy oz. and the scattered production of remaining countries at about 1500 troy oz. Roughly speaking, the world's 1917 output of platinum may, therefore, be estimated at about 131,500 troy ounces.

AVERAGE PRICES OF PLATINUM
(In Dollars per Ounce Troy)

	1915			1916			1917
		Russia, Crude Metal 83% Platinum			Russia, Crude Metal 83% Platinum		
	New York Refined Platinum	Petrograd	Ekaterinburg	New York Refined Platinum	Petrograd	Ekaterinburg	New York Refined Platinum
Jan....	41.10	.....	.....	90.05	61.25	61.10	87.83
Feb....	40.00	30.38	30.08	90.00	61.14	62.625	103.75
Mar...	39.50	30.38	30.08	90.75	.....	.....	103.33
Apr....	38.63	30.38	30.08	83.10	63.70	63.70	103.77
May...	38.50	30.57	30.08	80.50	66.64	65.92	105.00
June...	38.00	32.39	31.02	78.13	63.70	63.92	104.75
July...	38.00	32.39	31.02	63.60	63.21	63.92	103.88
Aug...	39.25	32.30	30.73	62.56	67.41	66.45	104.55
Sept...	50.00	.....	.....	84.25	67.41	66.45	104.13
Oct....	54.50	37.98	38.70	89.75	77.42	71.44	104.00
Nov...	62.63	47.46	46.64	101.25	.....	.....	104.52
Dec....	85.50	56.40	56.25	86.87	.....	.....	104.38
Year.	47.13	.....	.....	83.40	.....	.....	102.82

New York average for year 1914, $45.14; 1913, $44.88; 1912, $45.55; 1911, $43.12.

Early in 1917, the platinum shortage in the United States became threatening. Conditions were aggravated by heavy buying on the part of the jewelry trade. Platinum sales were discontinued at all U. S. assay offices, the intention being to conserve the metal for Government use. The U. S. Bureau of Mines took steps to increase the reserve of the metal and the public was informed that platinum in jewelry might be needed for war purposes. The problem of remedying the shortage appeared without solution until late in 1917, when F. W. Draper arrived in this country from Vladivostok with 40 poods (about 21,000 troy oz.) of platinum, collected in Russia with the aid of other American engineers, the Russian-English Bank of Petrograd, and U. S. Secretary of Commerce Redfield. Thus the U. S. Government was assured of a supply much needed for technical purposes. The market at the beginning of 1917 was quiet at $80@82½ per troy oz., but rose rapidly to $105 by the end of February, at which figure it remained during 1917, with occasional small fluctuations.

Quicksilver

The domestic production of quicksilver in 1917 was about 20% greater than that of 1916, which amounted to 29,932 flasks of 75 lb. each. The producing states, in the order of their importance in 1916, were California, Texas, Nevada, Oregon, Arizona and Washington. The bulk of the output came, as usual, from California and Texas, but Oregon in 1917 may have passed Nevada.

In Texas, the Terlingua district continued its production. Unworked parts of the Chisos property were extensively drilled, and a new type of rotary furnace was put in operation. Quicksilver was produced by the Mariposa Mining Co., which purchased the holdings of the Marfa and Mariposa, 90 miles south of Alpine. New ore was opened by other operators in the Terlingua district under the stimulus of high prices. Considerable development was carried on in Arizona, the demand for the metal stimulating exploration. The output for 1917 was greater than in 1916, but did not reach significant proportions, although there is hope for that through energetic development. The generally unsettled condition of the market and the failure on the part of the industry to develop fresh sources of supply or markedly improved metallurgical practice discouraged producers. Details of California production and an analysis of conditions in the quicksilver industry in that state are provided in an article by Murray Innes, published on a succeeding page.

That much greater quantities of quicksilver were not produced in 1917 to take advantage of the high price

average demonstrates the comparative inflexibility of the industry. Plant increases are costly, and there is no assurance that a high-price level—to justify them—

AVERAGE MONTHLY PRICE OF QUICKSILVER

(Per Flask of 75 Lb.)

	1916			1917	
Month	New York	San Francisco	London	New York	San Francisco
January	$231.50	$200.50	£16.75	$81.04	$80.20
February	283.50	300.63	17.875	120.90	116.25
March	213.75	223.75	19.00	113.30	112.50
April	140.375	147.50	17.75	115.64	115.00
May	95.10	97.50	16.50	105.93	105.00
June	73.00	73.81	16.50	84.34	86.20
July	79.80	79.90	17.30	107.80	102.18
August	74.75	75.00	17.50	115.00	111.10
September	75.50	75.06	17.50	112.21	110.90
October	79.40	75.80	19.50	100.94	100.62
November	79.25	75.50	18.25	102.50	100.75
December	80.00	78.00	18.63	115.90	111.65
Year	$125.49	$125.25	£17.75	$106.30	$104.36

will be maintained after the war, or, for that matter, even while it lasts.

The strength of the market at New York in the latter part of 1917 was largely the result of the freight congestion on the railroads and the scarcity of spot metal.

Quicksilver in California

BY MURRAY INNES*

In 1917 about 40 quicksilver mines and prospects were operated in California and about 20 of these properties were productive. Approximately 1000 miners were employed, and the monthly production of the state was approximately 2000 flasks, or a total production of 24,000 flasks for the year. The figures given by some of the smaller mines are not always accurate, as their output fluctuates from month to month, but it is now evident that compared with 1916 there was no considerable increase in quicksilver production in California.

The increased cost of labor and mine supplies affected quicksilver mining in California as it did all mining in the West, and it is safe to say that the labor costs alone averaged upward of $50 per flask. About 95% of the California output is produced by the use of Scott roasting furnaces, which have proved the most satisfactory. The construction of a 50-ton furnace, with condensers and accessories, calls for about 300,000 brick. These brick are, as a rule, burned adjacent to the furnace site, and it has not proved practicable to make them during the winter season. Under average conditions such a plant costs about $1000 per ton of daily capacity, and as the quicksilver must be shipped to New York for sale, several months' expenses have to be carried after the furnace is started before returns can be expected from sales, which is to say, for example, that on an average production of 150 flasks per month there would be about $50,000 tied up in the metal. In other words, after the mine has been purchased and later developed to supply 50 tons of ore daily, the owners are still facing an investment of about $100,000 before returns can, under present marketing conditions, reasonably be expected.

Quicksilver orebodies are, as a rule, irregular, erratic and uncertain. Few are large enough to justify an extensive plant and still fewer mines have in sight any considerable ore reserves. It is needless to say that quicksilver mining has not, during the last 25 years, been the source of swollen fortunes, and if the industry is to survive after the war it must at least receive more encouragement and protection than it has received in the past.

The advance in the market price of the metal was due entirely to scarcity, and the United States supply in first hands does not exceed 30 days' requirements. The sale of the metal was entirely competitive, and there were no combinations to control prices in any manner. The moderate increase in production during the last three years has not been due to new discoveries, but mainly to the fact that some of the older mines that had been shut down found it possible to treat, in existing furnaces, ores of lower grade and were, therefore, encouraged to reopen. A drop in the price for even a short period would cause a decrease in the present production from these low-grade ores, and this decrease would be accelerated by increased operating costs.

It is recognized that the present price of the metal is due entirely to war demands, and there is even now small inducement to invest in quicksilver mines or to build expensive plants that can hardly be productive—as explained above—within less than 12 months. The risk is too great that the demand may be over by the time any quicksilver can be produced and marketed. If, however, our Government were to do as Great Britain has done and fix a minimum price of at least $100 per flask, payable at San Francisco, and at this price accept, for the manufacture of munitions, etc., such quicksilver as might be offered during a stated period, I believe that a considerably increased production would result. The price suggested is below the present market and is practically that fixed by Great Britain for the metal when for government use. It is mainly the uncertainty regarding the future that makes the business unattractive, and this uncertainty must be eliminated by some such method, and for a stated period, if increased production is deemed necessary.

The Government now requires that all Eastern shipments be made in full carlots, and as it is manifestly impossible for small producers to make such shipments, they are, in California, at the mercy of various dealers and agents and often pay large commissions and discounts for small accommodations. The Government's acceptance of such small lots at San Francisco should eliminate this feature. Even if such purchases were not all required for munitions, the worst that could happen would be the possible accumulation by the Government of some quicksilver, which supply should, in my opinion, be carried as a reserve even in times of peace. If increased production is now necessary and is to be expected, the Government must be prepared to pay, in some small degree, for its total neglect of this little industry during the 25 years preceding the war. An increase in the present import duty from 10% *ad valorem* to, say, $15 per flask, to take effect after the war, would add the necessary assurance of future protection.

Few of the quicksilver mines in California are operating at a profit, even at the present price, and without this protection I am of the opinion that the low price for the metal that will prevail after the war may speedily put an end to quicksilver mining in this country. Now that the rich surface ores have been exhausted, California producers can no longer hope to compete on an even basis with the European output, produced at small cost and skillfully marketed by the Rothschild.

*Mining engineer, 217 Kohl Bldg., San Francisco, Calif.

Copper

THE situation of copper at the end of 1917 may be seen approximately from the figures in the accompanying tables. The first table gives the smelters' production of copper in the United States, this being the summary of reports received from all of the producers. The distribution by state of origin is approximately correct, but those figures are subject to more revision than is the grand total, for the reason that it is impossible to make a precise allocation at this early date. In the preliminary returns the outputs of Alaska, Nevada and New Mexico are usually understated. The copper production of the United States in 1917 was less than in 1916. It is to be distinctly understood, however, that the figures here given are the smelters' production, not the refiners'.

SMELTERS' PRODUCTION OF COPPER IN THE UNITED STATES

(In Pounds)

State	1914	1915	1916	1917
Alaska	24,288,000	72,621,844	115,933,315	91,918,000
Arizona	387,978,852	444,089,147	692,630,286	692,923,722
California	29,515,488	37,935,893	51,358,334	46,881,089
Colorado	10,104,579	8,126,000	9,802,183	12,028,000
Idaho	4,856,460	5,602,000	6,741,001	5,020,000
Michigan	157,089,795	241,123,404	270,058,601	273,445,747
Montana	243,139,737	268,027,557	351,995,058	274,799,545
Nevada	60,078,095	66,394,906	100,143,431	103,719,442
New Mexico	64,338,892	75,515,138	83,013,805	101,951,598
Utah	153,555,902	180,951,174	225,396,808	244,398,684
Washington	165,023	(a)	(a)	(a)
East and South	19,213,965	18,858,677	20,018,261	23,692,274
Other States	4,257,088	4,452,420	15,685,226	17,617,844
Totals	1,158,581,876	1,423,698,160	1,942,776,309	1,888,395,945

(a) Included in "Other States."

SMELTERS' TOTAL PRODUCTION

(In Pounds)

Source	1914	1915	1916	1917
North American ore	1,327,488,479	1,612,450,828	2,187,328,864	2,117,235,708
Foreign ore	50,101,308	44,749,105	73,391,517	76,078,047
Scrap	20,894,559	29,827,203	37,380,759	38,854,053
Totals	1,398,484,346	1,687,027,136	2,298,101,140	2,219,066,922
To foreign refiners	36,765,920	39,734,120	38,423,577	33,266,348
To American refiners	1,361,718,426	1,647,293,016	2,259,677,563	2,198,901,460
Crude copper imported	131,125,076	140,415,341	152,770,536	(a) 281,211,588
Total crude copper,	1,492,843,502	1,787,708,357	2,412,448,099	2,480,113,048

(a) Estimated on basis of nine months' returns.

The production of refined copper in 1917, as reported by the refiners, was 2,350,240,606 lb. against 2,300,000,000 lb. in 1916.

The second table gives the total supply of crude copper available to American refiners.

At the end of 1917 the electrolytic copper refining capacity of the United States was about 2,800,000,000 lb. per annum. Allowing 300,000,000 lb. per annum for the capacity for Lake copper, there was a total of about 3,100,000,000 lb. The actual production in 1917, excluding casting copper, was a little less than 2,300,000,000 lb. Although this supply of refined copper was short of actual requirements, it is probable that the United States now possesses an adequate refining capacity providing it can be used at the maximum. However, it is doubtful whether any such plant can be operated at 100% capacity, or anything like it, in view of the present conditions of inefficiency.

The New Cornelia Copper Co. was a new American producer in 1917 whose output is included with that of the smelters, although in fact it produces electrolytic cathodes direct from ore, which cathodes are shipped to a refiner simply for melting and casting in ingots, cakes or wire-bars.

The third table summarizes the world's production of copper in 1917. Besides the figures for the United States, Mexico, Canada and Cuba, which are based upon our own direct statistical reports, we have received late information from Australia, Peru, Chile, Bolivia, Japan, Russia, Africa, and Spain and Portugal. Although it is inevitable that final returns will alter our preliminary total of the world's production, it has been the experience of many years that the change is only a small percentage of the preliminary figure.

WORLD'S PRODUCTION OF COPPER (a)

(In Metric Tons)

Country	1914	1915	1916	1917
United States	525,529	646,212	881,237	856,570
Mexico	36,337	30,969	55,128	43,827
Canada	34,027	47,202	47,985	50,351
Cuba	6,251	8,836	7,816	9,622
Australasia	37,592	32,512	35,000	38,100
Peru	27,090	(f) 32,410	(f) 41,625	(f) 45,620
Chile	40,876	47,142	64,636	(g) 75,345
Bolivia	1,306	(e) 3,000	(e) 4,000	(e) 4,000
Japan	(c) 71,046	(c) 76,039	(c) 101,467	(g) 124,306
Russia	32,262	25,881	20,887	(e) 16,000
Germany	(b) 30,480	(e) 35,000	(e) 45,000	(e) 45,000
Africa	24,578	27,327	34,572	(e) 37,315
Spain and Portugal	(b) 37,099	(e) 46,200	(e) 42,000	(e) 42,000
Other Countries	(b) 25,176	(e) 25,000	(e) 25,000	(e) 25,000
Totals	929,649	1,083,730	1,406,353	1,413,056

(a) The statistics in this table are our own compilations, except where specially noted to the contrary. (b) As reported by Henry R. Merton & Co. (c) As officially reported. (d) Privately communicated to us from Japan (g) Estimated on basis of nearly complete reports.

UNITED STATES IMPORTS OF COPPER

(In Pounds)

	1916		1917	
	October	Ten Months	October	Ten Months
Ore, matte, etc., contents	13,087,490	150,962,096	14,331,931	142,483,807
Unrefined, blister copper, etc	14,731,276	229,578,498	18,747,533	289,911,088
Refined bars, plates, etc	5,782,771	8,411,163	4,362,544	10,388,164
Old and miscellaneous	976,388	8,643,233	1,614,589	17,997,760
Totals	34,577,925	397,594,990	39,056,597	460,780,819

UNITED STATES EXPORTS OF COPPER

	1916		1917	
	October	Ten Months	October	Ten Months
Ore, matte, etc., contents	1,174,695	4,676,049	573,241	4,873,733
Unrefined, blister, etc	4,653,542	11,326,996	4,256,707	10,421,344
Refined ingots, bars, etc	55,303,187	610,971,657	81,316,000	870,746,395
Plates and sheets	971,953	12,338,816	9,442,509	33,377,546
Wire, except insulated	2,280,505	20,049,866	2,008,119	21,006,669
Old and scrap	329,200	785,157	60,542	950,276
Composition metal, copper chief value	.....	.....	11,829	(a) 1,199,825
Copper pipes and tubes	.....	.....	523,007	(a) 6,165,581
Totals	64,713,082	660,148,541	98,191,954	948,741,369

(a) Figures cover period beginning July 1.

In the haste with which these statistics are presented it is unwise for us to attempt to draw many deductions from them. Moreover, some more detailed statistics are necessary. For example, we ought to know the production of American mines at least by quarters. Their total production in 1917 fell short of the production in 1916, but by no such amount as was lost during the strike. The probability is that the output of the mines had increased greatly during the first and second quarters of the year; the third quarter was a period of small production, while the fourth quarter was again a period of large production, but not up to the rate of the first half of the year.

We do not venture at present to draw any deductions from the apparent difference between smelters' production and refiners' production in 1917. It is manifest that the refiners did not make anything like the increased output that a year ago they were expecting to make. Their failure was due partly to strikes in their plants, partly to delays in obtaining raw material owing to freight congestion and strikes at the mines, and partly to the increasing inefficiency of personnel and plant.

The world's production of copper shows a small increase in 1917, but nothing approaching the increase of 1916 over 1915. The gains in 1917 were made in countries other than the United States, Japan being one of the most important sources of increased copper supply. Canada, Australia, Peru, Chile and Africa all showed increases, while besides in the United States there were decreases in Mexico and Russia.

Copper-Smelting and Refining Works of North America

The accompanying tables corrected up to Dec. 1, 1917, give the names of the companies engaged in copper smelting and refining in the United States, Canada and Mexico and the situation of their works. In the case of the smelteries the number of their smelting furnaces and the estimated annual capacity in terms of tons of charge, meaning ore and flux, but not including fuel, is given. It should be noted, however, that not all of the furnaces reported are in operation all the time. In most cases the data have been communicated to the *Journal* by the operating companies. However, the figures should be taken as only approximately correct. Some companies may have figured their annual capacity on the basis of the year of 365 days, and others on the basis of 350 days, or something else. Anyway, annual capacity is a rather variable figure. In modern practice a rather large quantity of ore is reduced directly to copper by charging it into the converter along with matte, this being shown separately in some cases by the last column of the table.

Plants were under construction in 1917 by the Great Western Smelters Corporation and the United Verde Extension Mining Co. in Arizona.

COPPER-SMELTING WORKS OF NORTH AMERICA

Company	Situation of Works	No. of Blast Furnaces	Annual Capacity	No. of Reverberatory Furnaces	Annual Capacity	No. of Converters	Annual Capacity in Ore(a)
American Smelting and Refining Co	Aguascalientes, Mex	10	800,000	..	.....	4	(b)
American Smelting and Refining Co	Perth Amboy, N. J	1	90,000	..	.....	3	(b)
American Smelting and Refining Co	Omaha, Neb	..	..	..	.....	2	(b)
American Smelting and Refining	El Paso, Tex	4	400,000	3	435,000	4	(b)
American Smelting and Refining Co	Matehuala, S.L.P., Mex	3	325,000	..	.....	..	.....
American Smelting and Refining Co	Hayden, Ariz	..	..	3	435,000	3	(b)
American Smelting and Refining Co	Sasco, Ariz	2	350,000	..	.....	2	.....
American Smelters Securities Co	Garfield, Utah	4	800,000	6	875,000	8	(b)
American Smelters Securities Co	Tacoma, Wash	2	375,000	1	144,000	4	(b)
American Smelters Securities Co	Velardeña, Dgo., Mex	3	250,000	..	.....	..	.....
Anaconda Copper Mining Co	Anaconda, Mont	3	1,750,000	8	1,750,000	7	105,000
Anaconda Copper Mining Co	Great Falls, Mont	2	280,000	2	330,000	2	49,000
Arizona Copper Co	Clifton, Ariz	..	..	3	360,000	3	.....
Compagnie du Boleo	Santa Rosalia, Mex	7	390,000	..	.....	..	.....
Calumet & Arizona Mining Co	Douglas, Ariz	2	646,300	4	564,700	6	42,900
Canada Copper Corpn	Greenwood, B. C	3	912,500	..	.....	2	.....
Canadian Copper Co	Coppercliff, Ont	8	1,300,000	1	160,000	5	60,000
Cananea Consolidated Copper Co	Cananea, Son	8	868,000	2	153,000	6	35,000
Consolidated Arizona Smelting Co	Humboldt, Ariz	1	100,000	1	100,000	3	12,000
Consolidated Mining and Smelting Co	Trail, B. C	5	450,000	..	.....	2	10,000
Copper Queen Branch, Phelps Dodge Corpn	Douglas, Ariz	10	1,225,000	3	275,000	8	40,000
Detroit Copper Mining Co. (c)	Morenci, Ariz	1	193,200	..	.....	3	9,800
Ducktown Sulphur, Copper and Iron Co	Isabella, Tenn	2	175,000	..	.....	..	.....
East Butte Copper Mining Co	Butte, Mont	2	240,000	..	.....	3	5,000
Granby Consolidated Mining, Smelting and Power Co	Grand Forks, B. C	8	1,440,000	..	.....	3	7,000
Granby Consolidated Mining, Smelting and Power Co	Anyox, B. C	4	1,196,000	..	.....	3	25,000
International Smelting Co	Tooele, Utah	..	.....	5	500,000	5	50,000
International Smelting Co	Miami, Ariz	..	.....	4	700,000	5	50,000
Ladysmith Smelting Corpn. (f)	Ladysmith, B. C	2	175,000	..	.....	..	.....
Mammoth Copper Mining Co	Kennett, Calif	5	730,000	..	.....	2	28,500
Mason Valley Mines Co	Thompson, Nev	2	547,000	..	.....	2	520,000
Mazapil Copper Co	Concepcion del Oro, Zac., Mex	3	216,000	..	.....	..	.....
Mond Nickel Co	Coniston, Ont	3	600,000	..	.....	3	60,000
Mountain Copper Co	Martinez, Calif	..	..	2	96,000	2	(e)
Nevada Consolidated Copper Co	McGill, Nev	1	175,000	5	900,000	4	40,000
Nichols Copper Co	Laurel Hill, N. Y	1	100,000	1	22,000	4	.....
Norfolk Smelting Co	West Norfolk, Va	1	87,500	..	.....	2	5,250
Old Dominion Co	Globe, Ariz	4	486,000	..	.....	1	5,944
Orford Works, International Nickel Co	Constable Hook, N. J	2	94,500	..	.....	3	.....
Penn Mining Co	Campo Seco, Calif	..	..	2	84,000	1	42,000
Pioneer Smelting Co. (f)	Corwin, Ariz	1	60,000	..	.....	..	.....
Santa Fe Gold and Copper Co	San Pedro, N. M	1	45,000	..	.....	..	.....
Shannon Copper Co	Clifton, Ariz	3	500,000	..	.....	2	8,000
Swansea Consolidated Gold and Copper Mining Co. (f)	Bouse, Ariz	1	190,000	..	.....	2	.....
Tennessee Copper Co	Copperhill, Tenn	5	1,000,000	..	.....	4	15,000
Teziutlan Copper Mining and Smelting Co. (f)	Teziutlan, Puebla, Mex	2	350,000	..	.....	3	.....
Cia. Metalurgica de Torreon	Torreon, Coah., Mex	2	175,000	..	.....	2	.....
U. S. Metals Refining Co	Chrome, N. J	2	200,000	..	.....	2	15,000
U. S. Smelting Co. (f)	Midvale, Utah	..	..	..	.....	..	.....
United Verde Copper Co	Clarkdale, Ariz	4	605,200	3	235,730	5	67,000
Wanakah Mining Co. (d)	Ouray, Colo	2	105,000	..	.....	..	.....
Western Sm. & Power Co	Cooke, Mont	1	110,000	..	.....	..	.....

(a) Raw ore smelted as flux. (b) Included in furnace tonnages. (c) Now known as Phelps Dodge Corpn., Morenci Branch. (d) Plant sold to Ouray Smelting and Refining Co. (e) No raw ore charged. (f) Not in operation.

ELECTROLYTIC COPPER REFINERIES OF THE UNITED STATES AND CANAD

Works	Situation	1914 Capacity, Pounds (a)	1915 Capacity, Pounds (a)	1916 Capacity, Pounds (a)	1917 Capacity, Pounds (a)
Nichols Copper Co	Laurel Hill, N. Y.	400,000,000	400,000,000	450,000,000	500,000,000
Raritan Copper Works	Perth Amboy, N. J.	400,000,000	400,000,000	460,000,000	450,000,000
Baltimore Copper Smg. and Rolling Co	Canton, Md.	336,000,000	354,000,000	600,000,000	720,000,000
American Smelting and Refining Co	Maurer, N. J.	216,000,000	240,000,000	240,000,000	288,000,000
United States Metals Refining Co	Chrome, N. J.	200,000,000	200,000,000	250,000,000	250,000,000
Balbach Smelting and Refining Co	Newark, N. J.	48,000,000	48,000,000	48,000,000	48,000,000
Anaconda Cop. Min. Co. (old plant)	Great Falls, Mont.	65,000,000	65,000,000	65,000,000	65,000,000
Anaconda Cop. Min. Co. (new plant)	Great Falls, Mont.	(b)	(b)	180,000,000	180,000,000
Tacoma Smelting Co	Tacoma, Wash.	48,000,000	120,000,000	130,000,000	204,000,000
Calumet & Hecla Mining Co	Hubbell, Mich.	65,000,000	65,000,000	65,000,000	65,000,000
Consolidated Mining and Smelting Co	Trail, B. C.	(b)	(b)	8,400,000	14,000,000
Totals		1,778,000,000	1,892,000,000	2,496,400,000	2,794,000,000

(a) Official figures furnished by the respective companies. (b) New works put into operation in 1916.

The Copper Market in 1917

At the beginning of 1917 the quotation for copper was 28¾c. and the market was dull. Consumers were reselling, and their offerings, frequently made in an injudicious way, depressed prices. On Jan. 10 the quotation was 26½c. and it looked as if consumers were nearly through reselling, the price having declined below the figure at which many of them had purchased. There was undoubtedly a buying power at a little below the existing level. The situation was such that, as one producer expressed it, 10,000 tons could not be bought without putting the price up 2c., and could not be sold without putting it down 4c. About the middle of January a change in sentiment led to a sharp rally, and at the end of the month the quotation was 30½c. A strike in the refinery at Perth Amboy and bad freight conditions, delaying the transportation of both crude and refined copper, were troublesome factors.

At the beginning of February the market was in a very strong position, producers having no copper to offer freely except for deliveries in July and later. There was

MONTHLY AVERAGE PRICE OF COPPER

	New York				London Standard			
Month	1914	1915	1916	1917	1914	1915	1916	1917
January	14.223	13.641	24.008	28.673	64.304	60.756	88.083	131.921
February	14.491	14.394	26.440	31.750	65.259	63.494	102.667	137.895
March	14.131	14.787	26.310	31.481	64.276	66.152	107.714	136.750
April	14.211	16.811	27.895	27.935	64.747	75.096	124.319	133.842
May	13.996	18.506	28.625	28.788	63.182	77.600	135.457	130.000
June	13.603	19.477	26.601	29.962	61.336	82.574	112.432	130.000
July	13.223	18.796	23.865	26.620	60.540	76.011	95.119	128.409
August	*	16.941	26.120	25.380	*	68.673	110.283	122.391
September	*	17.502	26.855	25.073	*	68.915	113.905	117.500
October	*	17.686	27.193	23.500	*	72.601	122.750	110.000
November	11.739	18.627	30.625	23.500	53.227	77.744	134.659	110.000
December	12.801	20.133	31.890	23.500	56.841	80.773	145.316	110.000
Year	13.602	17.275	27.202	27.180	61.524	72.532	116.059	124.892

New York, cents per pound. London, pounds sterling per long ton of standard copper. * No quotations.

a large demand for copper for February-April delivery, but no producer was able to furnish much of it, or, if he could put his hands on a little, he desired to couple it with later deliveries. There was no longer any copper offered for resale. In these circumstances, premiums were again paid, as high as 34c. being done, although the aggregate of such business was but trifling. Things became stronger as the month wore on, it becoming clearer that there was an unsatisfied demand of considerable proportions for copper to be delivered prior to July. At the middle of February the quotation of the major market was 32c. and at the end of February it was 32½c. Owing to transportation troubles, arrangements were made to bring copper from the West to New York by a roundabout way.

Early in March considerable business for third-quarter delivery was done at about 32c. and copper for prompt delivery fetched as high as 37c. A strike at the Nichols refinery added a new complication to the situation. During March it appeared, however, that domestic consumers were reluctant to contract for third-quarter delivery, which was the only supply for which the producers could sell in quantity. What was of more importance, though, was the prospect that the United States would soon enter the war. The announcement on Mar. 21 that copper producers had agreed to furnish the U. S. Government with about 45,000,000 lb. of copper at 16⅜c. for deliveries extending 12 months from Apr. 1, added to the confusion of thought. This tender by the producers was a patriotic gift, but many misunderstood it. At the end of March the price was 30½ cents.

Right from the beginning of April the dominating influence was uncertainty respecting governmental action, especially whether the American Government would requisition more copper at 16⅜c. and whether the Allied governments would be supplied on the same terms. There continued to be a good demand for early deliveries, but there was a distinct desire in several quarters to sell for third-quarter delivery at sharp concessions, on the theory that copper would certainly go no higher and probably would go lower. This bearishness was strengthened by the appreciation that without doubt domestic business had contracted somewhat. Although manufacturing plants were running at full capacity, their work was on a smaller kind of business, not footing up to so large a tonnage as when they were engaged on heavy rods and other heavy material that went rapidly through their works. On the other hand, an encouraging feature was the clearing up of the railway situation. By Apr. 20 the market was down to 25¾c., but at that level there was buying interest, and at the end of the month the quotation was up to 27 cents.

The strength of the market exhibited early in May was ascribable to the distinct intimation that the U. S. Government was going to buy a very large quantity of copper, and that the price would not be determined arbitrarily, but would conform to natural market conditions. This induced a buying movement of considerable proportions, confined to American manufacturers, which put the price up to 30c. at the end of May.

The strength continued into June, the major market being quoted at 30½c. at the middle of the month, while for June deliveries 33 to 35c. was realized. Before the end of the month, however, premiums largely disappeared. Important events this month were the strike at Anaconda, which attained serious proportions, and the announcement by Secretary Daniels that he was going to leave the price of copper for Government requirements to be determined by the Federal Trade Commission on the basis of average cost of production. At the end of June the quotation was 29¼c. Late in June it was reported that the Government had contracted with the producers for 60,000,000 lb. of copper at 25c., delivery extending over the ensuing 12 months. At the end of June the quotation of the market stood at 29¼c.

July opened dull, and about the middle of the month there developed real pressure from some quarters that wanted to sell copper, which put the price down to 24½c. However, copper was intrinsically strong, and the price could not remain so low, for buying was induced which was superior to all pressure to sell and advanced the market to 27½c. by the end of the month.

During July and August there was much discussion over probable action by the Government. There was a persistent belief in many consuming quarters that the Government was going to fix arbitrarily a low price for copper, and was going to require that itself, the Allies, and all consumers should be supplied at that price. Not all consumers, however, were deluded by such talk, many failing to see how the price to the outside consumer could be determined by anything but the law of supply and demand. Nevertheless, the mystery that was shrouding affairs in Washington had the effect of neutralizing the strong statistical position and destroying any incipient demand, and in the resulting dullness the market dropped to 24½c., at which figure August closed.

The big contract with the foreign government that was negotiated in Oct., 1916, had practically been filled by the end of July. At that time, some refiners had shipped away all the copper owed by them. The others had completed their deliveries, but some of the copper still remained here, owing to inability of the buyers to get ship capacity to take it away. During July and August the strikes in Montana and Arizona curtailed production very seriously, but August showed some improvement in the situation in Arizona. However, the curtailment of production was so serious that refiners who previously had been working on accumulated stocks began to find themselves compelled to shut down, Great Falls being the first refinery to be closed. Political tampering with copper was extremely irritating. The Federal Trade Commission had been put to work to examine the books of the producers and find out their costs of production. The purchase of 60,000,000 lb. at 25c. about the end of June was repudiated in higher quarters, and Secretary Daniels offered the producers 18⅞c. The producers refusing to accept that, it was later reported that the War Industries Board had agreed to advance to the copper producers 22½c., leaving the difference between that price and 25c. to be settled after receipt of the report of the Federal Trade Commission. These discussions in no way deprived the Government of necessary copper, for the producers supplied all that was required, but refused to bill for it at all. This finally resulted in the Government owing the producers about $10,000,000. At the end of August the statistical position of copper had become very strong, for domestic consumers were using up the supplies in their yards, while, on the other hand, production was diminishing. The Washoe and Great Falls works of the Anaconda company were closed on Aug. 27, wherefore there was complete suspension of operations in the Anaconda mines. The Great Falls refinery was idle. The Raritan refinery, which was the next to exhaust its stock of crude copper, was running at only two-thirds capacity; another large refinery was down to three-fourths normal production, and although the other refineries were still supplied with crude, their stocks were getting low. In spite of politics it was hard to keep the copper market down.

AVERAGE MONTHLY PRICES OF COPPER MANUFACTURES
(In Cents per Pound, f. o. b., Mill)

	1915		1916		1917	
	Copper Wire	Sheet Copper	Copper Wire	Sheet Copper	Copper Wire	Sheet Copper
January	14.80	19.50	25.70	31.00	37.00	42.00
February	15.19	20.25	28.66	34.50	37.00	42.12
March	16.09	20.63	29.13	34.50	38.11	43.00
April	18.03	22.38	31.10	36.00	38.20	42.20
May	19.95	24.50	33.75	37.88	36.56	40.30
June	21.13	25.25	32.50	38.00	35.00	38.75
July	21.63	25.50	30.25	38.00	34.12	38.22
August	19.25	23.90	31.38	37.00	32.85	36.85
September	19.34	23.50	32.00	38.00	31.00	35.00
October	19.28	23.50	32.35	38.00	31.00	35.00
November	19.84	24.44	35.56	40.37	28.83	33.17
December	21.81	26.00	37.00	42.00	26.84	31.74
Year	19.21	22.93	31.61	37.10	33.87	38.19

On Sept. 6 it became known that the War Industries Board had bought about 77,000,000 lb. of copper for the Allies at 25c. per lb., which led to a confident belief that the price that our own Government would pay would be the same. This advanced the market to 26½c., at which figure it stood when on Sept. 21 came the news of the fixing of the price at 23½c. f.o.b., N. Y., to take effect immediately and to continue for four months.

The summary fixing of the price at 23½c., which was by agreement between the War Industries Board and the copper producers, immediately threw the copper market into a state of chaos. The agreement in no wise took into account the status of existing contracts, the position of those houses that refine copper from raw material which they buy, or the complicated organization of the business in general.

New machinery was promptly created by the organization of the Copper Producers' Committee. It was immediately recognized that the supply of copper was insufficient to meet the demands of the Government and also of domestic consumers. Consequently, the latter were informed fully respecting the situation and their coöperation in adjusting their business to a ration basis, so to speak, was secured. By the end of the month the administration of the copper business had been pretty well organized. The Copper Producers' Committee became the controlling and distributing body. The actual business was done through the United Metals Selling Co., and the American Smelting and Refining Co., which became practically the business agents in the dealings with the Government. The United Metals Selling Co. handles the business with the U. S. Government, while the American Smelting and Refining Co. takes care of that for the foreign countries. Orders being received, these agents requisition the several producers to fill them according to information respecting their ability to supply just the kinds and shapes of copper that are needed. There is no question about the several producers obtaining their proper share of business, for there is not enough copper to meet the demand. The United Metals Selling Co., and the American Smelting and Refining Co. render their bills to the respective governments, and upon receipt of the money they remit to the producers who have filled the orders. These two concerns are, therefore, clearing houses for the business. Domestic orders are billed and payment is collected by the individual producer in the old-fashioned way. All of the copper is sold at 23½c. f.o.b. New York, cash basis. In deliveries to domestic consumers the business is done on that basis and freight is added, while in the event of a desire to arrange for payment in any other way than cash against bill of lading, private arrangements covering interest charges, etc., are made.

By the end of October the copper business was going along very smoothly, which was due largely to the generous coöperation of manufacturers, who abstained from demanding what they did not immediately need, who reduced the stocks in their yards and arranged to conduct their business with a smaller quantity of copper in semi-finished forms in circulation through their works. They drifted gradually to larger business with the Government, and less for domestic industry. About the only other feature of major interest was the development during December of considerable business with domestic consumers for delivery subsequent to January, some contracts being entered into for delivery as far ahead as June. This business was, of course, outside the agreement with the Government. But it was done at the price of 23½c. without any guarantee.

A conference in December between the Government and producers respecting the continuation of the agreement made on Sept. 21, for four months ending Jan. 21, 1918, reached no conclusion. Some smaller producers have bitterly protested their inability to meet expenses when receiving only 23½c. for copper.

The Butte District

BY B. B. THAYER*

The production both of copper and zinc in the Butte district was approximately normal during the first five months of 1917, but suffered a decided curtailment in June, July, August and September, reaching the lowest point in September. The falling off in output was due to the closing down of many of the mines and reduction works as a result of labor troubles instigated by a band of disloyal agitators, who endeavored by a well-established propaganda to curtail the output of copper and zinc, so necessary for the successful prosecution of the war in which we had rightfully become involved.

In the early part of June the North Butte Mining Co. suffered from one of the most disastrous shaft fires that ever occurred in the district, so far as loss of life was concerned, and the agitators, taking advantage of this opportunity, proceeded to organize a so-called union of the miners, known as the Metal Mine Workers, under the guidance of the Industrial Workers of the World. Many of the men joined the organization, largely as a result of threats and intimidation, and violence to individual workmen was freely used. A large number of miners, not wishing to take part in the disturbance, left the camp, and in the latter part of August the mines and smelteries of the Anaconda Copper Mining Co. were shut down. About the middle of September work was resumed generally throughout the district, and each day has shown a decided gain in the number of men working, and a marked increase in the tonnage of ore hoisted from the mines. The district is operating to above 90% of normal; but there is still a shortage of men, due largely to the fact that conscription has taken several thousand employees out of the camp. It should be borne in mind that the labor conditions from which Butte suffered were general in most of the large copper camps of the United States, and all of the so-called strikes were fostered by the same organization, namely, the Industrial Workers of the World.

On account of the shortage of manganese in the United States, a great deal of attention was given to this subject. A considerable tonnage was mined from the Hibernia mine, situated in the extreme western end of the district, and the Butte Copper and Zinc Co. has been giving the matter serious consideration, with fair prospects of success. If the tests now being made by the steel companies on manganese ore from Butte prove successful, it will mean much to the United States so far as available supply is concerned, as the normal supply of imported manganese to this country has been curtailed because of the lack of shipping facilities.

Notwithstanding the turmoil and agitation which existed in the district for several months, prosperity is in evidence everywhere, largely due to the fact that all of the operating companies have at all times evidenced a disposition to advance the wage scale in proportion to the increase in the cost of living.

Butte in particular and Montana in general have done more than their share in furnishing their full quota of men for the National Army, and the subscriptions to Liberty Bonds, the Red Cross, and for other charitable objects have been greater, it is stated, than in any similar district in the United States. The Montana regiments which have already answered the call to the colors compare most favorably with any body of soldiers in service, being composed of hardy men who have lived in a rigorous climate and who are accustomed to outdoor life; that they will give a good account of themselves on the battle line in France is a foregone conclusion.

*First vice president, Anaconda Copper Mining Co., 42 Broadway, New York.

Lake Superior Copper Industry in 1917

BY JAMES MACNAUGHTON*

The outstanding feature of the year's work was the rising costs of production, which will be shown by forthcoming annual reports. With the cost of coal almost double what it was in 1916 and other supplies exhibiting a proportionate increase, even the best of the companies will show a copper cost that leaves little if any margin of profit at the average selling price of pre-war years. At the established price of 23½c., such companies as Centennial, Lake, La Salle, Mass, Victoria and Winona cannot make a profit and still carry on the development essential to their growth and future existence. A curtailment of production in the district ensued and even some of the richer companies had to limit their operations to the more productive areas. The scarcity of labor was not so serious as in other districts, and the total copper produced did not show a great decrease from 1916. The older companies had to limit operations to some extent and little exploratory work was done, so that existing conditions do not make for the ultimate good of the district.

The only new company which began active operations was the Seneca, which is sinking a shaft to cut the Kearsarge lode north of the Ahmeek and below the Mohawk. On the other hand, the Adventure and the Keweenaw mines shut down entirely, Winona was turned over to tributers and other mines temporarily closed certain of their shafts. The year witnessed the passing of the Tamarack Mining Co., which was absorbed by the Calumet & Hecla.

The improvements made in mining were directed toward compensating for a decreased supply of labor, present and prospective. Power haulage was extended underground, even at increased costs per ton trammed when equipment was included, as this was the only solution of the production problem. For this work storage-battery locomotives seemed best adapted in most of the mines. The tendency was toward concentration of mining operations and increased shaft capacity, thereby decreasing overhead expenses. Increased production is the only possible offset for increasing cost of labor and supplies and decreasing copper content of the rock.

Metallurgical developments were few in 1917. Fine grinding in Hardinge conical mills became standard practice throughout the district, the extent of fine grinding in each plant being determined by local conditions. Flotation made no great headway, although plants are in process of construction at Calumet & Hecla and at White Pine. The amygdaloid properties offer no great field for flotation as the mine rock is lean and the slimes, unlike sulphides, are the leanest of the tailings.

*Vice president and general manager, Calumet & Hec'a Mining Co., Calumet, Mich.

Leaching on conglomerate ore proved a great success, but its application to amygdaloid ores is not likely for the same reasons that apply to flotation.

The year closed with all the larger mines forcing production to the limit of their labor facilities, at the expense both of development and exploration, in an effort to supply the war needs of the nation.

Copper Production in Arizona

By Walter Douglas*

Another abnormal year in the copper industry of Arizona ended with 1917. Not only was the quotational market price for the metal during the first seven months higher even than in 1916, but labor troubles of almost universal prevalence served to reduce and in some cases for months at a time to stop completely the output of some of the mines. The production for the first six months assumed record proportions. Stimulated by a 28c. copper market, a maximum output of the plant of the Inspiration Consolidated Copper Co. and from the mines of the United Verde Extension was attained. The New Cornelia, at Ajo, also entered the producing class, while the Magma and the mines at Imperial materially increased their production over that of the previous year. The high price of the metal permitted the older producers to attack low-grade orebodies at a profit, and mills and smelteries were operated to capacity. Under these favorable conditions, the production for the first half of 1917 reached the large total of 400,000,000 lb., though for the calendar year the production was only 660,000,000 lb., or 6% less than in 1916.

While the New Cornelia company, in the throes of construction, had experienced labor difficulties in the early part of the year, it was not until May and June that a concerted and apparently state-wide attempt was made to unionize or shut down the important camps. The first demand for union recognition and increased wages was made on the operators of Jerome. Recognition being refused but a wage increase granted, a strike was called for May 25. The Industrial Workers of the World, controlling the radical union and non-union element, injected themselves into the controversy and complicated the situation. The good offices of Federal Mediator McBride served to induce the union to withdraw its demand and the International Union of Mine, Mill and Smelter Workers, formerly the Western Federation of Miners, called off the strike on June 5, the smeltery of the United Verde having continued to run throughout. On June 26, the I. W. W. organization called a strike at Bisbee, and through specious arguments, intimidation and violence induced upward of half the miners to quit. On July 12, the sheriff deported from the district about 1300 of the most active disturbers, many of whom were Austrians or natives of the Balkan States. This strike was unique in that no demands were made by any regular labor organization, the International Union of Mine, Mill and Smelter Workers, Western Federation of Miners, through its president, repudiating and condemning the strike. July witnessed the complete suspension of all mining operations in the Globe-Miami district through a strike called by the International Union of Mine, Mill and Smelter Workers and the Industrial Workers of the World. The Morenci-Clifton mines were also closed down because of the refusal of demands of the Mexican employees for greatly increased wages.

In September, the President appointed a labor commission with Secretary of Labor Wilson as chairman to visit the scenes of labor disturbances and endeavor to mediate existing strikes and devise a means of preventing, if possible, the recurrence of similar troubles during the war. This commission arrived in Arizona in October, and at Globe, where operations had been resumed with reduced forces, provided for the reëmployment of those strikers who had not been guilty of treasonable speech or acts, and appointed a mediator whose decision should be final in matters which could not be adjusted between the operators and their employees. At Morenci and Clifton similar action was taken and the mines of that district were reopened in November.

The interesting 5000-ton leaching and electrolyzing installation of the New Cornelia Copper Co. was completed and put into operation, and from the start proved a complete success, not only technically and commercially, but the nominal output of the plant has been exceeded and the estimated costs confirmed. At the Copper Queen the removal of Sacramento Mountain, to expose for steam shoveling a large body of low-grade disseminated ore, was commenced. This operation involves the removal and transportation to rather remote points of 8,000,000 cu.yd. of overburden in order to make an estimated tonnage of 6,000,000 of ore available for openpit mining. A concentrator of 3000-tons daily capacity will be built at a point about three miles distant, in which the direct-flotation method will be followed. The United Verde Extension Mining Co. has designed and expects to have completed next spring a smeltery on the Verde River for the treatment of its ore by blast furnaces and converters.

*President, Phelps Dodge Corporation, 99 John St., New York.

Selling Australian Copper

Melbourne Correspondence

An important step with regard to the disposal of Australian copper, which before the war was sold almost entirely through the German metal ring, was taken in 1917, in the formation of a Copper Producers' Association. Arrangements were made for the association to have entire control of the shipping and selling for all the principal producers on lines similar to those adopted by the Zinc Producers' Association, protecting the mutual interests of the producers, and carrying out the shipping and sale on a coöperative basis. The policy of selling the bulk of the copper direct to the Imperial government will probably be further extended. The Australian production amounts to approximately 40,000 tons per annum, and is therefore of great importance to both the Commonwealth and the Empire generally. Application has been made to the Commonwealth treasurer for permission to register the Copper Producers' Association Pty., Ltd.

Membership of the association is confined to producing or treatment companies, and the Commonwealth will have a representative on the board of directors in

Melbourne, while the Imperial government has the right to appoint a representative to the London board. The association will have power to enter into contracts for the sale of all kinds of copper ores, mattes, unrefined and refined copper, and, after satisfying Australian requirements, will sell as much copper as possible to consumers in Britain, the entire proceeds being returned to producers, less the actual cost of administration and realization. The basis of all dealings will be equal treatment for producers, irrespective of tonnage, the government representation on the board protecting the small interests.

The following companies have agreed already to sell through the association: Wallaroo & Moonta Mining and Smelting, Electrolytic Refining and Smelting, Great Cobar, Hampden-Cloncurry Copper Mines, Ltd., Mount Cuthbert, Mount Ellicott, Mount Lyell Blocks Copper Mines, Mount Lyell Mining and Railway Co., Ltd., and Mount Morgan Gold Mining Co., Ltd. Other producers who may desire to join the association or sell copper through it may be included. The capital of the company is £50,000, divided into shares of £1 each, and the original issue is intended to be 10,000 shares.

Provisions in the memorandum of association state that each producing company holding not less than 500 shares, or any two or more producers holding together not less than 500 shares, will have the right to nominate one director. A director may be removed if the company he represents ceases to produce sufficient copper to justify his continuance on the board. An executive committee, on which the Commonwealth government will have a representative, will be selected by the board to carry on the general business of the association, and the articles of association include provisions that the Copper Producers' Association shall remain absolutely under British control.

The formation of the association, it is pointed out in a statement issued by the prime minister's department, is not intended to interfere with existing arrangements for the purchase of ores, mattes, etc., but to provide that the resulting refined copper reaches the market only through the coöperative association. An agreement already drafted and substantially approved stipulates that the basis of the association is absolute equality of treatment to each supplying company. In the event of complaints on this head, the Commonwealth government will be asked to appoint a referee to inquire into the complaint, the parties abiding by the decision.

Sulphuric Acid

Right from the first of 1917 the demand created and maintained by war conditions continued to increase the consumption of sulphuric acid, and the increase in the production was not commensurate with the consumption. This has been particularly noticeable in the case of acids of the higher strength, that is, 66° B. and oleum, although it is true also, but to a modified extent, with respect to acid of 60° B. The cause was, of course, the limited concentrating capacity and the relatively small number of contact acid plants in proportion to the regular chamber plants.

At the beginning of 1917 the 60° acid market was, relatively speaking, weak, in spite of the fact that a large supply was not available, most producers having sold the major portion of their production for some time ahead. At that time 60° acid commanded a price of $12@13 per ton at sellers' works. From the first of the year, however, the market for 60° acid steadily strengthened, the real strength first manifesting itself in the late summer, at which time prices were about $18@19 at sellers' works. Toward the end of 1917 acid of 60° was being sold at $22@25, with an increased scarcity.

The price range of 66° acid, while bearing no direct proportion to the price of 60°, had the same general tendency. The value of 66° acid was about $22 per ton at the beginning of 1917, and gradually enhanced to about $32@35 per ton at the end of the year.

While certain small producers of 60° acid still have an appreciable part of their production unsold (adopting as they do the procedure of selling their small productions on the open market) practically all of the larger manufacturers are sold out, or nearly so, until the end of 1918, so that from present indications the general acid situation is not likely to undergo marked change for the next half year or so at least.

Tin in 1917

No important new sources of tin were discovered in 1917, notwithstanding the stimulus given to this industry by the advance in prices as the year went on. In the United States the principal features of the year were: The acute shortage that developed at the end of November; the commandeering of tin stocks on Nov. 26 by the Navy Department; control of tin imports, beginning Dec. 10, by the American Iron and Steel Institute; and the progress made in the development of a tin smelting industry in the United States. Some important work was accomplished in this latter feature in 1917. The new smelting plant of the Williams Harvey Corporation, on Jamaica Bay, Long Island, was about 50% completed at the end of 1917, and is expected to be ready for operation in April, 1918. This plant is to have a nominal capacity of about 6000 tons of metallic tin per year, or a smelting capacity for about 10,000 tons of concentrates. The plant will have three reverberatory smelting furnaces and refining will be done by the special methods employed in England by Williams, Harvey & Co., Ltd., which has its principal works at Bootle, just outside of Liverpool, and another smaller plant at Hayle in Cornwall. The American plant is being erected by the Williams Harvey Corporation, in which the National Lead Co. of New York, and Williams, Harvey & Co., Ltd., of Liverpool, are jointly interested. An ore supply has been secured from Bolivia and with the advantage of a superior situation for the plant, the assurance of a permanent and growing market for tin in the United States, and the technical experience of the Williams-Harvey staff, there is every prospect that the new plant will have a successful career.

As will be recalled, tin smelting on a commercial scale was inaugurated in the United States several years ago by the American Smelting and Refining Co., at Perth Amboy, N. J. This company, which is the only important producer of electrolytic tin in the world, had planned to make extensive additions to its smelting capacity but

these extensions were not ready in 1917, owing to inability of manufacturers to deliver materials and equipment. It had in progress some interesting metallurgical experiments which may make radical changes in the tin-smelting industry. This company draws its ore supply from Bolivia, but on account of the electrolytic method of refining is able to produce tin of remarkable purity.

Prospecting for tin deposits in the United States revealed no new sources of commercial importance at this time. Considerable exploration was done in the Appalachian region, but as yet without important results. The known deposits in the Black Hills of South Dakota and the small deposit in the Franklin Mountains near El Paso, Tex., did not prove sufficiently attractive to invite exploitation in 1917. In Alaska a small production was made as usual from placers.

The principal stocks on hand in Europe and the United States at the beginning of December, 1917, as well as the supplies afloat are covered in the review of the tin market by J. H. Lang in this issue.

The Tin Market in 1917

BY J. H. LANG*

A review of the tin market in 1917 is either simple or complex, according to how the subject is treated. It is simple if one attributes everything that happened (as was practically the case) to the war. It is complex if one examines events minutely and analyzes in detail the various causes leading up to the present situation. This situation is best portrayed by price movements here and in London throughout 1917, shown in the accompanying tabulation giving the opening, high, low and closing price for Straits tin in the two markets.

COMPARISON OF NEW YORK AND LONDON MARKETS FOR SPOT STRAITS TIN

		London		New York		
1917		Pounds Sterling Per Long Ton	Equivalent in Cents per Pound (a)	Cents per Pound	1917	
Open	Jan. 2	180/15	38.40	43.00	Jan. 2	Open
High	Dec. 21	309/10	65.66	88.00	Nov. 29 to Dec. 19	High
Low	Jan. 2	180/15	38.40	42.25	Jan. 4	Low
Close	Dec. 31	281/10	59.82	82.00	Dec. 31	Close
Average, 1917				61.80		
Average, 1916				43.48		

(a) U. S. currency equivalent for London price, exchange being figured at $4.76.

It will be noted that lowest prices were made early in the year. The rise was progressive and almost unbroken except for occasional high premiums for spot in New York, with reversion to more normal levels depending on supply and demand. A widening of the spread between New York and London will also be observed, due to the same causes and to increased freight and insurance charges. At the very end of 1917, after the Christmas holidays, the London market broke, closing £28 below the price of Dec. 21, with sympathetic declines here. It is to be noted, however, that all New York prices toward the end of 1917 (practically during the whole of the month of December), owing to the great scarcity here, were almost entirely nominal, seldom representing the transfer of more than five tons and frequently less. Famine conditions in New York sufficiently explain these abnormal prices, but speculation must have played a part in producing such inordinate values at London and Singapore. The elimination of speculation at the end of 1917, through bringing tin under regulations similar to copper, lead and spelter, was probably responsible for the ensuing fall.

The New York market had to contend not only with the transportation and other problems but with official red tape and procrastination. Arrangements recently promulgated for the conduct of this business and transferring control to this side of the water from the British authorities to the American Iron and Steel Institute were six months in negotiation and were not completed at the end of 1917. The difficulties now confronting the trade are largely the result of delays in securing export permits from England and the Straits during this period. In addition the situation was aggravated during the last quarter by the shipping controversy with Holland, which interfered with supplies of Banka and Billiton tin. However, many of these vexatious and dangerous delays and difficulties, especially regarding permits and shipments, now seem in a fair way of adjustment. Also it is hoped that the production by the American tin smelters will reach substantial figures in 1918, and, with restriction of nonessential uses, insure a sufficient supply and at more reasonable prices.

MONTHLY AVERAGE PRICES OF TIN IN 1915, 1916 AND 1917

Month	New York			London		
	1915	1916	1917	1915	1916	1917
January	34.260	41.825	44.175	156.550	175.548	185.813
February	37.415	42.717	51.420	176.925	181.107	198.974
March	48.426	50.741	54.388	180.141	193.609	207.443
April	47.884	51.230	55.910	166.225	199.736	220.171
May	38.790	49.125	63.173	162.675	196.511	245.114
June	40.288	42.231	62.053	167.636	179.466	242.083
July	37.423	38.510	62.570	167.080	168.357	242.181
August	34.389	38.565	62.681	151.440	169.870	243.978
September	33.125	38.830	61.542	152.625	171.345	244.038
October	33.080	41.241	61.851	151.554	179.307	247.467
November	39.224	44.109	74.740	167.670	186.932	274.943
December	38.779	42.635	87.120	167.000	183.368	298.556
Average year	38.590	43.480	61.802	163.960	182.096	237.563

New York in cents per pound; London in pounds sterling per long ton.

Latest news is to the effect that no further shipments, at least against new business, will be permitted from England but that American requirements must be filled by direct shipment from the Straits or other sources of supply. If carried out this will tend, temporarily at least, to further complicate the situation, owing to the longer transit involved, the present small stock in New York constituting an inadequate reserve against delayed arrivals.

ANALYSIS OF TIN STATISTICS

(January to November, Inclusive)

Supplies	1917 Tons	1916 Tons	Deliveries	1917 Tons	1916 Tons
Straits	57,366	56,829	United Kingdom	15,448	15,707
Australian	349	2,357	Holland	915	880
Banca	14,824	17,223	Continent	11,885	12,607
Billiton	998	2,491	United States	53,314	52,036
Standard	7,525	7,331	Lost in transit	.....	255
	81,062	86,231		81,562	81,485
Net decrease	5,169		Net increase	77	

TIN IN STOCKS AND AFLOAT

	Stock—Tons		Afloat—Tons		Total—Tons	
	1917	1916	1917	1916	1917	1916
Europe	4,891	4,710	8,400	7,931	13,291	12,641
United States	1,592	2,850	5,727	6,260	7,319	9,110
	6,483	7,560	14,127	14,191	20,610	21,751
Decrease	1,077	....	64	.....	1,141	.....

TIN VISIBLE

Jan. 1, 1917—21,085 tons; Jan. 1, 1916—17,005 tons; Increase—4,080 tons.
Nov. 30, 1917—20,610 tons; Nov. 30, 1916—21,751 tons; Decrease—1,141 tons.

Comparative statistics for 1916 and 1917 are presented herewith. Many of the figures for 1917 are estimated, but are regarded as measurably accurate. It will be observed that so far as the situation as a whole is concerned, the changes were immaterial and did not account for the extreme market fluctuations.

*Specialist in tin, L. Vogelstein & Co., 42 Broadway, New York.

Lead

THE production of lead from domestic sources exhibited a small decrease in 1917. To what extent this was attributable to the curtailment of production instituted in the autumn is uncertain. The production of lead from foreign ore increased considerably; wherefore the grand total of the output of American refiners was larger than ever before. The increased production from foreign ores was due to the resumption of smelting in Mexico.

PRODUCTION OF LEAD (REFINERY STATISTICS) (a)

(In Tons of 2,000 Lb.)

Domestic:	1913	1914	1915	1916	1917
Desilverized	261,616	318,697	305,160	330,189	317,952
Antimonial	16,345	17,177	24,601	22,819	17,068
S. E. Missouri	133,203	177,413	185,849	206,105	204,869
S. W. Missouri	22,312	25,448	20,312	33,128	40,575
Totals	433,476	538,735	535,922	592,241	580,464
Foreign:					
Desilverized	54,774	28,475	43,301	17,832	49,213
Antimonial	2,300	1,119	2,883	3,304	1,858
Totals	57,074	29,594	46,184	21,136	51,071
Grand totals	490,550	568,329	582,106	613,377	631,535

(a) These figures include the lead derived from scrap and junk by primary smelters.

IMPORTS OF LEAD DURING FIRST TEN MONTHS

	1915	1916	1917
Lead ore, long tons	54,634	90,735	74,769
Lead contents, lb.	15,246,854	29,648,109	37,080,482
Lead in bullion, lb.	81,651,884	16,192,013	67,470,096
Lead, pigs, bars and old, lb.	768,843	10,522,980	6,875,138

EXPORTS OF LEAD DURING FIRST TEN MONTHS

	1915	1916	1917
Pigs, bars, etc., from domestic ore, lb.	140,131,961	176,393,359	82,535,280
Pigs, bars, etc., from foreign ore, lb.	30,793,031	(a) 16,244,637	33,489,641

(a) Period beginning July 1.

The Lead Market in 1917

January opened with the price for lead at about 7½c. New York and about 7⅜c. St. Louis. During the first half of the month the market was about stationary at both places. An important factor was the delay in transportation from Western producing points to Eastern consuming points. Lead shipped from St. Louis in the first half of November had not been received in New York as late as Jan. 17. The normal time of transit from St. Louis to New York is about two weeks. Labor troubles having developed at Perth Amboy, and there being also troubles at Western refineries, especially owing to increasing inefficiency of labor and difficulty of obtaining supplies, the market advanced, and January closed with quotations of 8@8¼c. New York and 7.90@8.10c. St. Louis.

At the beginning of February there existed a situation where anybody requiring lead on the spot in New York might have to pay any kind of a premium. This was due to the traffic troubles. There was an immense quantity of lead in transit. Consumers, failing to receive what they had previously bought and expected to have by this time, placed additional orders, on the theory that the more they had coming to them the better would be their chances of getting some of it. At the end of February the quotation was 8½@9¼c. New York and 8½@9¼c. St. Louis. The American Smelting and Refining Co. resisted the advance, making its contractual deliveries and booking business with its regular customers at prices as much as 1c. per lb. below what was being realized by other sellers.

In March, after the market had risen to 9¾c., the situation became a little easier, owing to gradual relief from the freight congestion, and also the selling of bonded lead, which could easily be entered for domestic consumption with payment of the duty under the existing circumstances. Also some smelting furnaces in Mexico were put in operation, giving hope of a somewhat increased supply. At the end of March the market was down to about 9 cents.

During the first half of April the market was quiet, but about the middle of the month, when some of the important producers became reserved in their selling policy, pending negotiations with the Government, prices stiffened. Some rather large business was done, and it appeared that manufacturers were contracting for more supplies than they needed immediately, anticipating that Government requirements would create a squeeze and make lead hard to get. April closed with a quotation of 9½@9⅞ cents.

During May the market became very exciting, the primary cause being the distinct intimation that the quantity of lead to be required by the Government would be very great indeed. Consumers bid up prices against each other. Their behavior was depreciated by the large producers, who foresaw that continued extravagance in this market would restrict consumption later, to the disadvantage of everybody, and who conjectured (rightly as appeared subsequently) that consumers were overbuying. They begged certain large consuming interests to give back to them lead supplies with which they might regain control of the market, but the consumers would not do so. The statement that the Government requirements in May and June would not exceed 2500 tons failed to relieve the tension and May closed with a quotation of 10@11 cents.

MONTHLY AVERAGE PRICE OF LEAD

Month	New York			St. Louis			London		
	1915	1916	1917	1915	1916	1917	1915	1916	1917
January	3.729	5.921	7.626	3.548	5.826	7.530	18.606	31.167	30.500
February	3.827	6.246	8.636	3.718	6.164	8.595	19.122	31.988	30.500
March	4.053	7.136	9.199	3.997	7.375	9.120	21.883	34.440	30.500
April	4.221	7.630	9.288	4.142	7.655	9.158	21.094	34.368	30.500
May	4.274	7.463	10.207	4.182	7.332	10.202	20.347	32.967	30.500
June	5.932	6.936	11.171	5.836	6.749	11.123	25.170	31.011	30.500
July	5.659	6.352	10.710	5.531	6.185	10.644	24.611	28.137	30.500
August	4.656	6.244	10.594	4.520	6.088	10.518	21.946	29.734	30.500
September	4.610	6.810	8.680	4.490	6.699	8.611	23.151	30.786	30.500
October	4.600	7.000	6.710	4.499	6.898	6.650	23.994	30.716	30.500
November	5.155	7.042	6.249	5.078	6.945	6.187	26.278	30.500	30.500
December	5.355	7.513	.....	5.266	7.405	.....	28.807	30.500	.....
Year	4.673	6.858	.....	4.567	6.777	.....	22.917	31.359	.....

New York and St. Louis, cents per pound. London, pounds sterling per long ton.

During June the market was in the shadow of the uncertainty as to what the Government was going to require. Producers told their customers frankly that after the Government had requisitioned for its needs there probably would not be enough lead for everybody unless consumption were curtailed. In talking this way, the producers simply reflected what they had been told by the Government. Everybody was under a misconception, for which the responsibility focused in Washington, and it was this more than anything else that induced the extravagant advance in the market. Before the middle of June the quotation was 11@12c. Later the situation eased a little, but the month closed with the quotation of 11@11¼ cents.

After prolonged conversations, the Government contracted with the producers for 8000 tons of lead to be

delivered in July at 8c. per lb. The lead producers' committee prorated this among the several producers, and also attended to distribution among manufacturers on orders from the Government. During July the market became a little easier, in spite of the strike in Southeastern Missouri. The month closed with the quotation of 10½@11 cents.

During August the lead market continued strong, but as the month progressed the tone became easier. At the end of the month the quotation was 10@10¼c. However, the inevitable was impending. Right from the beginning of September the market plunged downward. The high prices had curtailed consumption so effectively that buying power was diminished, while on the other hand production had increased, in spite of the labor troubles in Missouri, more than anybody had supposed. By Sept. 20 the market was down to 7⅞c. It rallied to 8c. and halted there as if bottom had been reached. But this was not so, for a new downward plunge ensued, and by Oct. 10 the price was 7c. As fast as the American Smelting and Refining Co. reduced its price, and failed to develop business, insistent sellers undercut and carried the market down to some new low level. On Oct. 23 the market stood at 6c. The American Smelting and Refining Co. then took the bull by the horns and cut to 5½c., taking everybody by surprise.

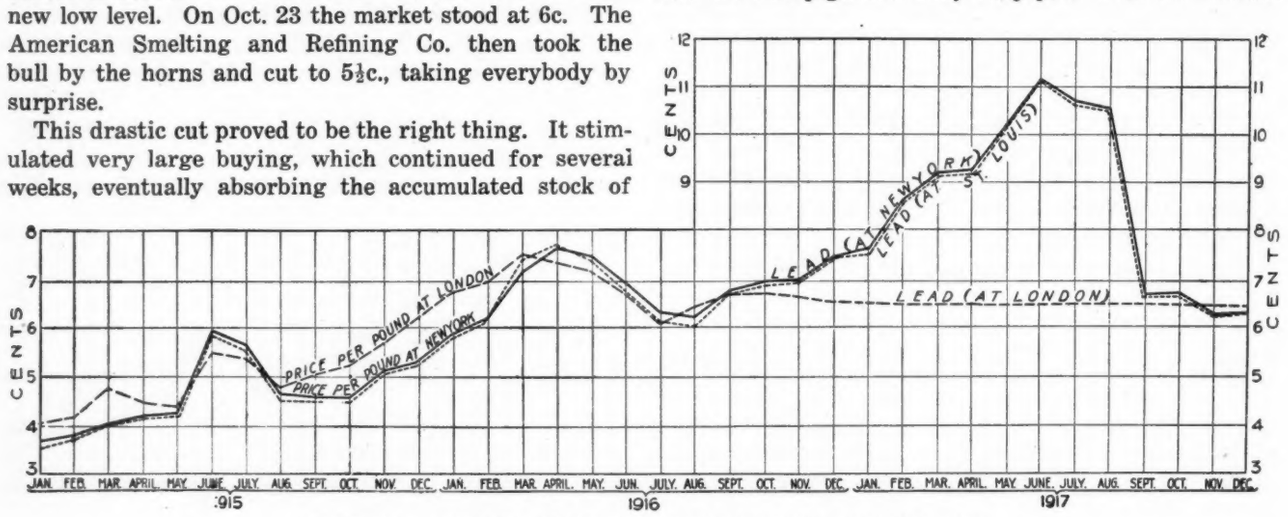
This drastic cut proved to be the right thing. It stimulated very large buying, which continued for several weeks, eventually absorbing the accumulated stock of the producers and inducing an advance in the market to 6¼c., which was quoted on Nov. 13. Following that the market became more quiet, but continued very strong, and 1917 closed with a quotation of 6⅜ cents.

The Government in July had contracted with the producers for 25,000 tons of lead to be delivered during August, September and October at 8c. per lb. Before October had ended the market price was far below that figure. The producers released the Government from its contract and enabled it to take advantage of the cheap market. Beginning with November, arrangements were made whereby the Government purchased its requirements on the basis of the average quotational price at St. Louis.

The lead market in 1917 exhibited the free play of supply and demand. Probably the market would have culminated in March with a price a little above 9c. if it had not been for the erroneous ideas about the immense quantity to be required by the Government, for which Washington was responsible. However, the extravagant prices that were thus developed had the natural effect of stimulating production and curtailing consumption. Within a few weeks the situation changed from an absence of stock to the rapid accumulation of stock, and curtailments of production were announced by producers which only a few weeks previously had been exerting themselves to make a maximum output. During the autumn there was a considerable accumulation of unsold stock. However, the slump in the market, which went beyond what conditions really justified, led to an absorption of stocks, and at the end of 1917 the market was again strong but dull.

White Lead and Oxides in 1917

The entrance of the United States into the war was responsible for a spectacular rise in pig lead, which culminated in an official price of 11.10c. for corroding lead in New York. This price was established early in June and continued for about three months. In the meantime there were outside sales considerably above this figure, as high as 12½c. being paid. The advance began in January and continued uninterruptedly until the peak was reached in June, there having been seven advances of ½c. each in about five months. At no time did the lead pigments fully keep pace with the advance on the metal. There was no change on dry white lead until pig lead advanced 1½c., and even then it went up only ½c. This was followed by a ¼-c. rise late in April and by four advances of ½c. each during the next four weeks, making the aggregate 2¾c. from the opening price of the year. White lead in oil followed a similar course, but the aggregate advance amounted to 3c. per lb., while the advance in pig lead had been 3½c. over the same period. For many months the spread between pig lead and all of the pigments was narrower than it had ever been before, and the average for the entire year was considerably below that of all previous years.



MONTHLY AVERAGE PRICES OF LEAD IN 1915, 1916 AND 1917

At the beginning of 1917 the net price of dry white lead in large lots was 8¾c. per lb., and in June it had reached 11½c. Then there was a decline to 9c., which was the closing figure. White lead in oil advanced during the same period from 9¾c. to 12¾c., with a subsequent reaction to 10¾ cents.

Oxides followed the course of the pig-lead market a little more closely than white lead, as much less time elapses between the purchase of the metal and its conversion into salable material. At the beginning of 1917 litharge sold at 9¼c. and it reached 12½c. in June, after-

ward declining to 9½c., while red lead advanced from 9¾c. to 13c. in the first half of the year and closed at 10 cents.

The differential between all of the pigments and the nominal quotation for pig lead was unusually wide at the close of the year, due in some measure to the unsettled state of the metal market, as the manufacturers of lead products were awaiting more stability to the price of pig lead before revising their own quotations. All materials entering into the production of lead pigments were at an abnormal level, some of them being fully 100% above the average of many years before the war began. The cost of labor, coal, acetic acid, linseed oil and packages seriously curtailed the apparent margin between pig lead and its products, and under prevailing conditions that margin had to be abnormally wide to afford manufacturers anything like what was considered a fair profit in the past.

Linseed oil, an important factor in the ultimate cost of paint, sold above $1 per gal. throughout the year and reached $1.25. As a consequence and by reason of diminished building operations the sale of all painting materials was below that of 1916. The consumption of lead pigments in other industries was, however, large, and the export trade, chiefly to South America and the Far East, increased in 1917 over that of the corresponding period of the previous year.

Silver-Lead Smelting Works of North America

The accompanying list, which has been corrected to Dec. 1, 1917, gives the several silver-lead smelting works of the United States, Mexico and Canada, together with the number of their furnaces (in all cases, blast furnaces) and their estimated annual capacity in tons of charge. By "tons of charge" is meant ore and flux, but not coke. The ton of charge is manifestly the correct unit. In the case of a self-fluxing ore, the ton of ore smelted and the ton of charge smelted is the same thing. In other cases fuel and labor have to be used in smelting the flux as well as in smelting the ore, and the economy of smelting depends largely upon the percentage of ore in the charge. The management of this question is about the highest exercise of the metallurgist's skill.

AMERICAN SILVER-LEAD SMELTING WORKS

Company	Place	Furnaces	Annual Capacity (a)
American Smelting and Refining Co...	Denver.....	7	510,000
American Smelting and Refining Co...	Pueblo.....	7	380,000
American Smelting and Refining Co...	Durango.....	4	210,000
American Smelting and Refining Co...	Leadville.....	10	510,000
American Smelting and Refining Co...	Murray.....	8	657,000
American Smelting and Refining Co...	East Helena.....	4	306,000
American Smelting and Refining Co...	Omaha (b).....	2	82,000
American Smelting and Refining Co...	Perth Amboy (b).	4	170,000
Con. Kansas City Sm. and Ref. Co....	El Paso.....	6	380,000
Bunker Hill & Sullivan Min. and Concentrating Co.....	Kellogg, Ida.....	3	600,000
Selby Smelting and Lead Co.....	Selby., Calif.....	3	210,000
Ohio & Colorado Smelting Co.....	Salida, Colo.....	4	345,000
United States Smelting Co.....	Midvale, Utah....	7	530,000
Northport Smelting and Refining Co...	Northport, Wash.	2	216,000
Pennsylvania Smelting Co.....	Carnegie, Penn....	2	60,000
International Smelting Co.....	Tooele, Utah.....	5	600,000
Totals, United States.....		78	5,766,000
American Smelting and Refining Co...	Monterrey.....	10	584,000
American Smelting and Refining Co...	Aguascalientes....	1	40,000
American Smelting and Refining Co...	Chihuahua.....	7	400,000
American Smelters Securities Co.....	Velardeña.....	3	150,000
Compañia Metalurgica Mexicana.....	San Luis Potosi (c)	10	250,000
Compañia Metalurgica de Torreon.....	Torreon.....	8	360,000
Compañia Minera de Peñoles.....	Mapimi.....	6	325,000
Totals, Mexico.....		45	2,109,000
Consolidated Mining and Smelting Co.	Trail, B. C.....	4	140,000

(a) Tons of charge. (b) Smelt chiefly refinery between-products. (c) Not being operated, but plant is expected to start in the near future.

The figures in the accompanying table are in most cases from official communications of the respective companies. Estimated capacity is always a matter of more or less uncertainty, and for this reason the figures given ought to be accepted only as approximations.

Construction of the Bunker Hill & Sullivan plant was completed in 1917, which materially increased the lead-smelting capacity. The total capacity of the Mexican works at the end of 1917 is a little over 2,000,000 tons per year; of the American works, about 5,765,000 tons. With respect to the American works, such capacity has never been in use at one time. More or less of it represents capacity idle because of changes in the conditions of ore supply.

The Empire Smelting and Refining Co. rebuilt an old plant at Deming, N. M., and operated until October, when its works were destroyed by fire.

The Ontario Smelting and Refining Co. is building a smelting plant near Baxter Springs, Kan., which will be equipped with Newnam automatic Scotch hearths.

Lead Products Other Than White Lead

BY J. R. WETTSTEIN*

A summary of the industry of lead products, apart from white lead, in 1917, must of necessity take large account of the demand created by the war, since it need scarcely be said that lead is essentially a war material. Lead products cover a wide range of articles used in various fields of activity, from the peaceful to the warlike, but a brief review will readily disclose that under existing conditions a large percentage of the production must find its way into those industries and channels directly related to the war.

Mixed Metals: Probably the most important line—aside from the actual munitions of war—is that of mixed metals, a generic term, embracing solders, babbitt metals and casting metals, all of which call for an alloy of lead with other metals, chiefly tin and antimony, with lead the principal factor.

The bearing metals are all directly related to industrial activity, and the tremendous war demand upon industry and transportation was responsible for a decided increase in the consumption of mixed metals in 1917. Nor does it seem at all likely that the high prices ruling for lead, tin and antimony had any deterrent effect upon the demand, which emphasizes the stress of the necessity under which these industrial activities called for supplies. The year will probably mark a record in the volume of this class of lead products, and indications point to a continuance of the record-breaking demand.

Oxides of Lead: These, consisting principally of red lead and litharge, find their market in painting material, glass and rubber manufacturing. The rubber industry was particularly active during 1917 and called for large quantities of litharge. Moreover, the export demand from practically all the countries of the world where trading is possible was a pronounced and rather unusual feature of the business for the year. The foreign demand at times, in spite of high prices,

*President, United Lead Co., 111 Broadway, New York.

was such that grave difficulty was encountered in taking care of it. The close of the year found the situation much easier, however, with excess capacities well equal to supplying any sudden additional demand that may spring up.

Shot: This article—composed entirely of lead—finds its way into the channels of sport. Practically all the shot manufactured in this country—about 30,000 tons—is loaded into shot shells and used for sporting purposes in the field and over the traps. This business suffered considerably in 1917 because of the high prices of sporting ammunition, and it is doubtful whether the normal volume can be restored until normal prices return.

Lead Pipe: This is used principally in the building trades, and a study of building statistics reflects the condition of the lead-pipe industry. Doubtless due to the high cost of all building materials, the figures on the record of new construction—particularly dwelling-house construction—appear to have reached a very low ebb. Even though current prices for lead pipe are 50% lower than they were in the middle of 1917, it does not seem likely that a normal demand can appear until all building materials have reached a normal level of prices. This particular industry, therefore, may be looked upon as very dull, with immediate prospects not encouraging. The demand for Governmental and industrial purposes was relatively large, but this particular requirement constitutes a small percentage of the total in normal times.

Sheet Lead: This product also finds its market in the building trades, and what has been said of lead pipe, on its use in this channel, can be applied equally to sheet lead. The Governmental and industrial demand is a considerably larger item than in lead pipe, because of which circumstance the business done in 1917 probably reached normal proportions. The war preparations and the building of ships contributed a large share of the demand, the continuance of which, however, is rather uncertain. The chemical industry, which was so largely extended in 1916, was not so much in evidence in its requirements of sheet lead during 1917, but whatever volume of business has been lost in this field has been fully offset by the Governmental activities and the shipbuilding industry.

Munitions: However much general lines of lead products as thus far reviewed may have suffered in the total by decreased consumption, the tremendous demand of the Government for munitions more than offset the shrinkage. In two important munitions of war, the shrapnel shell and the rifle cartridge, lead is a large factor. While it is true that this form of munitions was manufactured in this country for the Allies previous to our entering the war, it is probably equally true that present capacities of the country in the manufacture of small-arms ammunition and shrapnel balls are at the moment more greatly taxed than they were at any time previously. These two war materials call for a tremendous consumption of lead, and the early estimates of quantities required, coming at a time when no surplus stocks of lead were available, were probably directly responsible for the enormous advance in the price of lead and all its products which occurred during the first half of 1917. A continuance of this demand must, of course, be expected, however cheerless it may be to contemplate.

The Coeur d'Alene District

BY STANLY A. EASTON*

The events of first importance in the district in 1917 were the blowing in of the No. 1 furnace of the Bunker Hill lead smeltery, on July 5, and the extension of the railroad tracks of the Oregon-Washington Railroad & Navigation Co. up Beaver Creek to serve the zinc-lead-silver properties of Sunset Peak and a similar extension up Pine Creek to serve the zinc-lead-silver producers of the Pine Creek district. These new railway facilities will greatly improve operating conditions for these groups of mines, and should result in a much greater activity in the section served. There are still a considerable number of undeveloped and unworked zinc-lead-silver veins in both of these sections, which should be operated in a small way, now that dependable and cheaper transportation is available. It is upon such developments that the extension of the district and increase of its production must depend in the future. Another event of importance was the launching of an all-steel dredge by the Yukon Gold Co. to work the deep placers at Murray.

There were no mine developments of importance nor new lead producers brought in during 1917 in the Cœur d'Alene district of Idaho, but the output of lead, silver and zinc closely approximated that of preceding years. The lead and silver production of the Hecla, the Hercules, the Tamarack & Custer and the Bunker Hill & Sullivan showed no falling off from former years and probably in the aggregate represented a considerable increase.

An additional bonus when lead sells in New York for 8c. and over per pound was voluntarily granted to their employees by the companies operating in the district in March, 1917, the total bonuses amounting to $1.25 per shift, in addition to the minimum or base rate, and although lead fell to a price below 8c. per lb., the payment of these bonuses in full was continued by all companies. Strikes, I. W. W. agitation, and general unrest, particularly during the spring and summer months, hampered practically all industries in the Northwest, including the mining camps of Montana and the logging and saw-mill camps of northern Idaho, but the Cœur d'Alene district was entirely free from such troubles. There was some scarcity of labor and a marked tendency on the part of workmen, because of the certainty of employment, to shift about from job to job and take more than the usual amount of time for recreation. Nevertheless, all the properties of the district carried on their operations at nearly full capacity.

The Bunker Hill smeltery, which blew in its No. 1 furnace July 5, started the No. 2 furnace a few weeks later; the silver and lead refineries went into operation as required, to take care of the bullion from the furnaces, and at the end of the year shipments of refined, desilverized lead and bars of fine silver and gold were regularly going forth. Copper in the form of copper sulphate was accumulated but none marketed in 1917. The gold mentioned is not won from Cœur d'Alene ores, but from the smelting of iron-sulphide concentrates from the Alaska-Juneau mine at Juneau, Alaska.

---

*Manager, Bunker Hill & Sullivan Mining and Concentrating Co., Kellogg, Idaho.

Southeastern Missouri Lead District

By H. A. WHEELER*

AS USUAL, over 90% of the lead output of Southeast Missouri was furnished by the Bonne Terre, Flat River, and Leadwood districts, in St. Francois County, while Madison County furnished practically all of the remainder from the Mine La Motte and Fredericktown districts. The shallow diggings of Washington, Jefferson and Franklin Counties contributed such trifling amounts as to be almost negligible. Ordinarily such astonishingly high prices for lead would have stimulated production from these shallow diggings, for although the output of a single lot or lease is insignificant, the number of leases is such that the aggregate production at times has been important. But the high wages paid in the big mines and the great scarcity of labor resulted in most of the "diggers" being attracted to the Flat River mines.

Labor participated in the prosperity, wages reached a record high point and there was an insistent demand for men until Dec. 1, when a cut of 75c. a day was made throughout the district. As wages were still unusually high, however, the men quietly accepted the reduction, and no protest was made by the miners' union. An aggravating labor disturbance occurred in July, when, through outside influences if not directly attributable to the I. W. W., foreign laborers were suddenly driven out of the district by the American miners. Most of the foreigners are Hungarians and were engaged in shoveling and work of that character, so that the disturbance caused almost complete cessation of operations for about a fortnight, when troops took possession of the district and restored order and safety. Since then most of the foreigners have returned and there has been no further trouble, but one company of soldiers is quartered in the heart of the district and will probably remain until the end of the war. While there was little loss of life, there was considerable sacking of the homes of the foreigners, who were roughly treated and badly scared until the troops arrived. Many of the leaders of this outbreak were subsequently arrested, and most of them are now in the penitentiary.

Little Exploration or Development of the District by Outside Interests

Little outside interest was shown in the search for new deposits, nor was any attempt made to acquire partly developed properties in the district, although there are several available tracts that will eventually pass into the producing list. The lead market was so high as to create a lack of confidence in its permanence, so there was less interest by outsiders than in previous lead booms that were based on lower but more stable prices. Diamond drills were operated by New York interests west of Irondale in Washington County, on lands held under option on Big River, where it is reported they found an orebody of considerable promise. Eastern interests obtained an option on the Palmer property, in Washington County, which is a large tract that has produced over $2,000,000 from the shallow diggings, but no diamond drilling was done in 1917, although several experts reported favorably.

The St. Joseph Lead Co. bought the old La Graye diggings, at Bonne Terre, 54 years ago, paying $1,000,000 (in stock) for 946 acres—an investment which at that time seemed to be the rankest of wildcats, as such lands were valued then at $5 to $25 an acre. The lead produced during the first year of operation cost $34,096.10 and was sold for $17,275.24. An effort to raise working capital by the sale of $100,000 in bonds realized only $30,000, although it finally cost the company $175,000 for this $30,000 loan. Charles B. Parsons took charge of the property in 1867, at a time when the outlook was anything but promising for its development, for, with other discouragements, the plant was 12 miles from the nearest railroads, which could be reached only by means of wretched, hilly roads. When the pioneer Leschot diamond drill—the first in this country—was used on the property in 1869 with its 200 ft. of cast-iron rods, the first two holes drilled were blank, but later good ore was struck at depths ranging from 90 to 120 ft., this being the only place in the county where disseminated lead is so shallow. The first dividend, amounting to 1%, was paid in 1874, but dividends were discontinued from 1877 to 1880. In 1879, with the aid of the adjoining Desloge Lead Co., a 13½-mile narrow-gage railroad was built to Summit, on the Iron Mountain R.R. This construction cost $150,000 and eliminated the use of hundreds of teams. The adjoining Penn tract of 344 acres, on which were a few shallow diggings, was bought in 1883 for $100,000, and the valuable Desloge property, which comprised 3218 acres, was acquired in 1886 for $400,000 in stock.

Growth of the St. Joseph Lead Co.

Since then there has been a steady, substantial growth in all departments of the St. Joseph Lead Co. The narrow-gage road, which was the salvation of the company, was replaced by nearly 100 miles of well-built, finely equipped, standard-gage track, the fine towns of Bonne Terre, Herculaneum and Leadwood were built to house the employees, the acreage was expanded to over 20,000 and the original 100-ton mill replaced by two mills of 2000 tons and one of 4000 tons' daily capacity. There are now more than 20 shafts on the property and a modern smeltery of 100,000 tons' annual capacity has been built. The lead output has expanded, especially since the company recently absorbed its junior Doe Run Lead Co., and it produced a larger tonnage in 1917 than the rest of the district combined, the value of the output exceeding $18,000,000, while the dividends paid for the year aggregated $4,900,000. The $1,000,000 capitalization of the old La Grave diggings has developed, through the untiring efforts of Charles B. Parsons, into the largest lead mine in this country, but only after a long, hard, up-hill struggle.

The 6000-kw. turbine power plant at Rivermines[1] was completed in 1917 and is now furnishing 6600 volts, which operate plants at Flat River, Leadwood and Bonne

*Mining engineer, 408 Locust St., St. Louis, Mo.

[1]Described in "Engineering and Mining Journal," Nov. 17, 1917.

Terre, five to 10 miles distant. The gas-producer plant at Rivermines, where 48 men were employed as against 20 in the new plant, was dismantled and cheap slack coal is now used instead of the best grades of Illinois coal required by the gas-producers. The gas power plant at Bonne Terre is also shut down, but held in reserve for emergencies.

A new shaft was sunk at the No. 3 Doe Run mill, where a new orebody was discovered. A 40-acre slime-settling pond, having a depth of 40 ft., was placed in use at Bonne Terre, a large dam being constructed with tailings, and a mile of track is being extended to make a still larger slime pond out of the waste "chats" or tailings when the first pond has filled up. Extensive improvements are under construction at the smelting plant at Herculaneum and will increase its economy and efficiency.

Lower Mining Costs with Shoveling Machines

The Desloge Lead Co. had a successful year and the output was increased 20% over its previous high record. The installation of five Myers-Whaley shoveling machines made a considerable cut in the costs of hand shoveling, heretofore characteristic of the district, and proved so satisfactory that mechanical loading of the lead-bearing rock will soon be exclusively adopted on this property. Automatic sprinklers were introduced in the mill and a water-softening plant was installed for purifying the boiler water.

The St. Louis Smelting and Refining department of the National Lead Co. operated its mines at St. Francois, in the Flat River district, throughout 1917, except for a short interruption in the summer caused by the outbreak against the foreigners. The ore from the Baker Lead Co., on Big River, and the initial output of the Boston-Elvins mine at Elvins were treated at the National mill.

Federal Lead Co. Completes 3000-Ton Mill

The Federal Lead Co., the second largest producer in the district, made a new record in 1917, and increased its output 15% above its previous high record of 1916. This production would have been larger had not the company shut down its new No. 4 mill and the Phoenix mine, in Madison County, in October, both of which are still idle. No. 4 mill, with a daily capacity of 3000 tons, was completed in the spring of 1917, and is built directly over a new orebody with the mine shaft at the mill door. No. 9 shaft was completed about 10 years ago, although it was not operated until 1917, when it was cleaned out, relined and equipped with a steel headframe, and the orebody is now being developed by drifting. The central turbine power plant at No. 3 mill (4000 tons capacity) was enlarged by the addition of two 360-hp. water-tube boilers.

The Baker Lead Co. mined an average of 500 tons daily, assaying 5.5 to 5.75% lead, from its one shaft on the edge of Big River. This ore was hauled over the Mississippi River & Bonne Terre R.R. to the National mill, 10 miles distant, where it was concentrated, and then smelted at the Collinsville plant of St. Louis Smelting and Refining Co. This property of the Baker Lead Co. is the initial investment of Boston interests in this district and was formerly known as the Jake Day tract, that had been repeatedly optioned and drilled by local men, and always turned down until taken over by the Boston interests. Most of the ore thus far mined has been recovered from under Big River, at a depth of about 400 ft., and was unusually rich.

The Boston-Elvins Co. owns the 40-acre tract at Elvins, formerly known as the Jones Forty and which adjoins the western side of the old Central Lead Co.'s 1000-acre grant. The shaft, which is 565 ft. deep and encountered considerable water, was completed about Jan. 1, 1917. Approximately 10,000 tons of ore was mined in 1917 before the pump broke down and the mine was flooded. A new 16-stage centrifugal pump of 1500-gal. capacity will be installed to unwater the mine. Three-ton skips are used to hoist the ore. Excessive water and hard luck caused an outlay reported to amount to $200,000, whereas $30,000 to $50,000 would usually cover the total expenditures to date in this district for similar development.

Madison County Mines to Use Steam-Shovel Stripping Methods

The Mine la Motte, where lead mining has been carried on for two centuries, is now controlled by the Missouri Metals Co. The company purposes expanding the property into a huge, low-grade proposition, using steam shovels to strip 20 to 120-ft. of barren limestone that overlies the disseminated ore. The ore horizons in the Flat River district are at a depth of 300 to 600 ft., whereas at Mine la Motte the surface is relatively shallow, as most of the shafts are only 100 to 200 ft. deep. For several years steam shovels have been employed to strip the surface clays, which carry more or less coarse galena and granules of carbonate of lead, the latter being washed into low-grade concentrates before shipment to the smelteries. It is now intended to abandon underground mining and operate as deep quarries, crushing the entire output in a 64 x 84-in. crusher to 8-in. size and then picking out the ore on traveling belts. The mill is being enlarged to a capacity of 1500 tons to treat the picked ore and a new power plant, equipped with two Diesel engines, was built. Considerable copper, nickel and cobalt occurs on this property, especially in the upper part of the La Motte sandstone that underlies the disseminated ore, and more attention will be given to these metals.

Shaft sinking on the Schulte tract at Fredericktown was discontinued in the summer of 1917, after the death of H. J. Cantwell, who was interested in this property and did more to develop the disseminated lead belt than any other pioneer in Missouri.

The Missouri Cobalt Co., a Canadian corporation operating the old North American Lead property at Fredericktown, completed its new mill and smeltery. A 300-ton mill was completed in 1917 and a new refinery is being rebuilt to replace the one recently lost by fire. Copper as well as metallic nickel and cobalt will be the main output, with lead as byproduct, from the chalcopyrite and linnaeite mined. The former owners recovered as high as five tons of copper a day from these mixed sulphides.

The old Catherine or Phoenix mine was operated until Nov. 1 by the Federal Lead Co. under a lease. The ore is shallow and little water was encountered, but the orebodies are not so large as in the Flat River district, so the plant was shut down until operating conditions become more normal.

The old Einstein mine, 10 miles west of Fredericktown, on the St. Francois River, was mined by New York interests for tungsten. More or less wolframite occurs with the argentiferous galena in a fissure vein in hard porphyry. The vein is narrow and tight, and it did not pay when operated as a silver-lead producer some years ago, when there was no demand for the tungsten. A 25-ton mill was erected and the tungsten concentrates were shipped to the East.

In prospecting for lead in the western part of Iron County, a small fissure vein carrying more or less argentiferous copper sulphides was found in porphyry. This is now being developed on a moderate scale.

American Smelting and Refining Co. in Mexico in 1917

BY S. W. ECCLES*

The year 1917 witnessed a gradual resumption of the American Smelting and Refining Co.'s mining and smelting operations in Mexico. Substantial tonnages of high-grade lead ore were produced from the mines in the Santa Barbara and Cuatro Cienegas districts.

A considerable tonnage of high-grade lead ore, and a somewhat small tonnage of zinc ore, were produced at Santa Eulalia and moved to smelteries in the United States.

The copper mines at Tepezla and Matehuala have been constantly increasing their output until they are now producing on a normal basis.

Operations were resumed at the Angangueo mines in Michoacan in the latter part of 1917. None of the plants or mines of the company was damaged during the year.

Record Petroleum Production

Preliminary estimates by John D. Northrop, of the U. S. Geological Survey, indicate that the quantity of petroleum produced and marketed in the oil fields of the United States in 1917 reached the record-breaking total of 341,800,000 bbl., a quantity nearly 14% greater than the former record output of 300,767,158 bbl., established in 1916. The production was apportioned among the major fields as shown in the table:

U. S. PETROLEUM OUTPUT, 1916 AND 1917

Field	1916	1917
Appalachian	23,009,455	24,600,000
Lima-Indiana	3,905,003	3,500,000
Illinois	17,714,235	15,900,000
Oklahoma-Kansas	115,809,792	147,000,000
Central and North Texas	9,303,005	11,000,000
North Louisiana	11,821,642	8,700,000
Gulf Coast	21,768,096	24,900,000
Rocky Mountain	6,476,289	9,200,000
California	90,951,936	97,000,000
Other fields	7,705	.....
Totals	300,767,158	341,800,000

The salient features of the industry in 1917 were the record levels reached and firmly maintained by prices of crude oil at the wells and the enormous demand, which absorbed not only the current output of the wells but necessitated a net draft of about 21,000,000 bbl. on oil in storage, principally in California and Illinois. The surface reserve of crude oil in the United States at the end of 1917 is estimated at 153,000,000 barrels.

The principal sources of new production in 1917 were: Estill County, Kentucky; Butler County, Kansas; Carter County, Oklahoma; Wichita and Harris Counties, Texas; Converse County, Wyoming; and Los Angeles County, California.

*Since writing these notes Mr. Eccles died Dec. 31 at St. Augustine, Fla. He was one of the vice presidents of the American Smelting and Refining Co., 120 Broadway, New York.

The Aluminum Industry

In the first quarter of 1917 substantially the same conditions held as for 1916. The price of aluminum ingot No. 1 grade was around 37c. per lb. Spot sales by scrap dealers or resales in small quantities were generally made at a price ranging from 55 to 60c. per lb. The price during the last three quarters of 1917 remained fairly stable around 38c. per pound.

On the declaration of war with Germany, business of all kinds in the United States was compelled to seek a readjustment to meet the new conditions. Certain industries, as for example the manufacture of pleasure automobiles, reduced their production, and following such reductions the abnormal scrap and resale market for aluminum gradually disappeared. Simultaneously with these reductions came, however, an increase of production of materials for war purposes for the United States Government.

AVERAGE MONTHLY PRICE OF INGOT ALUMINUM (*a*)

(At New York, in Cents per Pound)

Year	1913	1914	1915	1916	1917	Year	1913	1914	1915	1916	1917
Jan.	26.31	18.81	19.08	55.00	60.77	July	23.38	17.66	32.38	60.20	55.48
Feb.	26.04	18.81	19.22	58.00	59.00	Aug.	22.70	19.88	34.50	60.00	48.88
Mar.	27.05	18.50	19.00	60.25	59.00	Sept.	21.69	19.94	47.75	61.88	43.64
April	27.03	18.16	18.88	59.50	59.92	Oct.	20.13	18.50	50.00	65.05	38.90
May	26.44	17.95	22.03	59.00	59.84	Nov.	19.35	18.00	57.75	65.12	37.22
June	24.68	17.75	30.00	61.50	60.00	Dec.	18.88	18.96	57.13	63.00	36.40
Year							23.64	18.63	33.98	60.71	51.59

(*a*) The quotations summarized in the above table reflect transactions in the market for uncontracted supplies, which is mainly in metal offered for resale, including ingot remelted from scrap. The bulk of the aluminum production enters consumption on long-time contracts. Previous to the war the differences between the contractual and the open markets were not very great; but since the beginning of the war they have been very large. Thus in 1915 contract prices ranged from 20 to 31c.; in 1916 from 31 to 37c., and in 1917 from 37 to 38c.

Among the war purposes for which aluminum is used may be mentioned the high explosive ammonal, machine-gun parts and numerous aircraft parts, particularly engines. Another important use of aluminum for military purposes is in mess equipment such as water bottles, cups, plates, and meat cans. It is safe to say that nearly all the aluminum produced in the United States now is either going directly into materials used by the United States Government or its Allies or indirectly into other materials which are being used for Government purposes.

In 1917 a large additional producing capacity was brought into operation at Badin, N. C. At this place a new power plant was started in June and it has run substantially at capacity ever since. Construction work was begun on a large power plant in the Little Tennessee River and this plant will probably be completed in the latter part of 1918. Power will then be taken to Maryville, Tenn., where additions to the aluminum-producing capacity have already been made to utilize this power.

Zinc

THE production of spelter by ore smelters in the United States was 685,436 tons in 1917, compared with 680,018 tons in 1916. This includes the spelter derived both from domestic and foreign ores and also a small tonnage obtained from dross, etc., by smelters whose chief business is the reduction of ore. It is to be noted that there is also a rather large production of spelter by dross smelters, pure and simple. Their production is not included in the present report.

The total for 1917 is the aggregate of the reports of 30 smelters operating 47 works. So far as we know, these were all the smelters who produced in 1917. The list of the zinc smelters, together with the number of their retorts at the end of 1917, is given in an accompanying table.

All of these smelters reported their production by quarters, which figures are summarized in a separate table.

The statistics of total production for the whole year showed an increase in 1917. From the annual figures alone, an erroneous deduction might be made. The quarterly figures reveal the true situation. Production continued at a high rate during the first two quarters, probably culminating about the beginning of the second quarter. The third and fourth quarters show a severe curtailment. At the end of the fourth quarter the rate of production was doubtless lower than the average for that quarter.

Operating smelters reported a total of 196,560 retorts in December, 1917. Of these, the number in operation on Dec. 15 was 127,193. The number of retorts in construction at that time was 840, at Terre Haute plant of Grasselli Chemical Co., which was completed in 1917, and started operation. The works of the Athletic Mining and Smelting Co. and of the United Zinc Smelting Corporation, at Moundsville, W. Va., were also completed. The latter plant will probably start operation in March or April of this year.

At the end of 1917 at least 13 works, operated by 10 smelters, had been closed down and a considerable number of these works had been or were to be dismantled.

Electrolytic spelter was produced in the United States in 1917 by five works, the chief producer being the Anaconda Copper Mining Co. The total production of electrolytic spelter was 29,451 tons.

The stock of spelter at works on Dec. 31, being the aggregate of the reports of all the smelters, was 60,415 tons, compared with 16,085 tons at the beginning of 1917. These figures include both high-grade and common spelter.

SPELTER PRODUCTION, 1913–1917, BY QUARTERS

(In Tons of 2000 Lb.)

Reports of Ore Smelters Only

District	I	II	III	IV
1913				
Illinois	27,924	28,523	26,118	28,986
Kansas-Missouri	22,006	23,820	19,204	20,127
Oklahoma	21,430	21,840	18,502	21,458
Others (a)	20,722	20,153	19,238	18,211
Totals	92,082	94,336	83,062	88,782
1914				
Illinois	31,005	32,482	32,512	34,588
Kansas-Missouri	13,939	14,659	13,193	11,633
Oklahoma	22,563	22,960	22,945	23,999
Others (a)	22,717	22,715	24,106	24,296
Totals	90,224	92,816	92,756	94,516
1915				
Illinois	35,786	39,511	41,791	44,577
Kansas-Missouri	14,090	24,554	32,152	40,256
Oklahoma	24,713	26,984	28,613	31,095
Others (a)	26,255	30,575	31,360	34,830
Totals	100,844	121,624	133,916	150,758
1916				
Illinois	45,344	45,547	41,953	48,651
Arkansas	.....	.....	2,977	4,660
Kansas-Missouri	38,513	42,488	39,447	33,948
Oklahoma	34,994	38,786	42,604	52,680
Others (a)	37,853	39,873	41,514	48,186
Totals	156,704	166,694	168,495	188,125
1917				
Illinois	48,766	47,217	40,361	39,763
Arkansas	5,596	6,894	7,597	5,631
Kansas-Missouri	25,212	25,200	20,135	15,678
Oklahoma	53,029	57,255	48,480	45,956
Electrolytic	8,533	9,060	5,359	6,499
Others (a)	42,014	41,696	39,736	39,769
Totals	183,150	187,322	161,668	153,296

(a) With the exception of one plant in Colorado these are all Eastern works. In the fourth quarter of 1915 and 1916 is included Anaconda and other electrolytic production.

PRODUCTION OF SPELTER

(In Tons of 2000 Lb.)

By Ore Smelters Only

States	1913	1914	1915	1916	1917
Arkansas	.....	.....	.....	7,637	25,715
Colorado	8,637	8,152	8,984	8,908	8,488
Illinois	111,551	130,587	161,665	181,495	176,106
Missouri-Kansas	85,157	53,424	111,052	154,396	86,227
Oklahoma	83,230	92,467	111,405	169,064	204,720
Electrolytic	.....	.....	.....	10,963	29,451
East and others (a)	69,687	85,682	114,036	147,555	154,729
Totals	358,262	370,312	507,142	680,018	685,436

(a) Includes Anaconda and other electrolytic production in 1915.

The Zinc Market in 1917

At the beginning of January common spelter was quoted at 9¼c., St. Louis basis. There was rather a peculiar situation in that smelters in Kansas and Oklahoma, who were experiencing gas trouble, found themselves short of spelter with which to make their contracted deliveries and figured in the market as buyers. Their demands having been satisfied, the market eased off, but then rallied and rose to about 9¾c. on Jan. 17, on short covering by speculators. The month closed with a quotation of 10@10¼ cents.

The idea was still entertained among smelters generally that spelter would have a "come-back," but the prolonged absence of European buying tended to get on the nerves of producers, though the apparent tenacity with which the quotations held around 10c. during February and March gave some hope. However, important interests were under no illusion as to what was happening, and were sellers of spelter right along

MONTHLY AVERAGE PRICE OF SPELTER

Month	New York 1915	New York 1916	New York 1917	St. Louis 1915	St. Louis 1916	St. Louis 1917	London 1915	London 1916	London 1917
Jan.	6.386	16.915	9.619	6.211	16.745	9.449	30.884	89.810	48.329
Feb.	8.436	18.420	10.045	8.255	18.260	9.875	39.819	97.762	47.000
Mar.	8.541	16.846	10.300	8.366	16.676	10.130	44.141	95.048	47.000
Apr.	10.012	16.695	9.459	9.837	16.525	9.289	49.888	99.056	54.632
May	14.781	14.276	9.362	14.610	14.106	9.192	68.100	94.217	54.000
June	21.208	11.752	9.371	21.038	11.582	9.201	100.614	68.591	54.000
July	19.026	8.925	8.643	18.856	8.755	8.473	97.250	50.750	54.000
Aug.	12.781	8.730	8.360	12.611	8.560	8.190	67.786	51.587	54.000
Sept.	13.440	8.990	8.136	13.270	8.820	7.966	67.841	52.095	54.000
Oct.	12.800	9.829	7.983	12.596	9.659	7.813	66.536	54.159	54.000
Nov.	15.962	11.592	7.847	15.792	11.422	7.672	88.409	56.023	54.000
Dec.	15.391	10.665	7.685	15.221	10.495	7.510	89.409	55.842	54.000
Year.	13.230	12.804	8.901	13.054	12.634	8.730	67.553	72.071	52.413

New York and St. Louis, cents per pound. London, pounds sterling per long ton.

when contracts could be placed without unduly weakening the market.

What was happening was that stocks were increasing, and probably had begun to increase previous to the end of 1916, and, owing to the freight congestion,

AVERAGE PRICE OF ZINC SHEETS

(In Cents per Pound)

	1915	1916	1917		1915	1916	1917		1915	1916	1917
Jan...	9.25	23.40	21.00	May..	19.13	24.00	19.00	Sept...	16.00	15.00	19.00
Feb....	12.38	24.50	21.00	June..	29.25	19.50	19.00	Oct...	16.00	15.20	19.00
Mar..	13.50	25.00	21.00	July...	27.00	15.60	19.00	Nov....	20.00	18.25	19.00
April..	14.13	25.20	20.44	Aug...	18.80	15.00	19.00	Dec...	22.00	21.00	19.00

Average for the year 1915—17.37 cents, 1916—20.14 cents, 1917—19.62 cents

Note—These are base prices for ordinary size sheets, in carload lots, f. o. b. LaSalle-Peru, Ill., less 8% discount.

the surplus was going into railway cars, and not piling up at the works. When, however, in April the freight congestion was relieved, there was no longer any doubt respecting the situation. Consumers began to get out of railway cars the surplus for which they had contracted, and, having no need to enter the market for further supplies, stocks began to pile up rapidly in the

ZINC-SMELTING CAPACITY OF THE UNITED STATES

(Number of Retorts at End of Years)

Name	Situation	1916	1917
American Spelter Co. (a)	Pittsburg, Kan.	(b) 896	(b) 896
American Steel & Wire Co.	Donora, Penn.	9,120	9,120
American Zinc and Chem. Co. (a)	Langeloth, Penn.	7,296	7,296
American Zinc Co. of Ill.	Hillsboro, Ill.	4,864	4,864
American Zinc, Lead and Smg.Co.(a)	Dearing, Kan.	4,480	4,480
American Zinc, Lead and Smg.Co.(a)	Caney, Kan.	6,080	6,080
American Zinc, Lead and Smg. Co. (c) (a)	Neodesha, Kan.	3,760	3,760
American Zinc, Lead and Smg.Co.(c)	E. St. Louis, Ill.	4,864	5,620
Arkansas Zinc and Smelting Corpn.	Van Buren, Ark.	2,400	3,200
Athletic Min. and Smelting Co.	Fort Smith, Ark.	(d)	1,664
Bartlesville Zinc Co.	Bartlesville, Okla.	7,488	5,184
Bartlesville Zinc Co.	Blackwell, Okla.	8,800	9,600
Bartlesville Zinc Co.	Collinsville, Okla.	13,440	13,440
Bartlesville Zinc Co., Lanyon-Starr Branch	Bartlesville, Okla.	3,456	3,456
Chanute Spelter Co. (a)	Chanute, Kan.	1,280	(g)
Collinsville Zinc Co. (a)	Collinsville, Ill.	1,984	(b) 1,984
Eagle-Picher Lead Co.	Henryetta, Okla.	3,000	(b) 3,000
Edgar Zinc Co.	Carondelet, Mo.	2,000	1,982
Edgar Zinc Co.	Cherryvale, Kan.	4,800	5,040
Fort Smith Spelter Co.	Fort Smith, Ark.	2,560	2,560
Grasselli Chemical Co.	Clarksburg, W. Va.	5,760	5,760
Grasselli Chemical Co.	Meadowbrook, W. Va.	8,544	8,520
Grasselli Chemical Co.	Terre Haute, Ind.	(d)	3,360
Hegeler Zinc Co.	Danville, Ill.	5,400	5,400
Henryetta Spelter Co.	Henryetta, Okla.	3,000	(a) 3,000
Illinois Zinc Co.	Peru, Ill.	4,640	(b) 4,640
Iola Zinc Co. (h)	Concreto, Kan.	(b) 660	(b) 660
Joplin Ore and Spelter Co.	Pittsburg, Kan.	(j) 1,792	(g)
J. B. Kirk Gas and Acid Co. (a)	Iola, Kan.	3,440	3,440
Kusa Spelter Co.	Kusa, Okla.	3,720	7,520
La Harpe Spelter Co.	Kusa, Okla.	4,000	(k)
Lanyon Smelting Co.	Pittsburg, Kan.	448	(h) 448
Robert Lanyon Zinc and Acid Co.	Hillsboro, Ill.	3,200	(b) 3,200
Lanyon-Starr Smelting Co. (e)			
Matthiessen & Hegeler Zinc Co.	La Salle, Ill.	6,168	6,168
Mineral Point Zinc Co.	Depue, Ill.	9,068	9,068
Missouri Zinc Smelting Co. (a)	Rich Hill, Mo.	(j) 448	(b) 448
National Zinc Co.	Bartlesville, Okla.	4,970	4,256
National Zinc Co.	Springfield, Ill.	3,800	4,480
Nevada Smelting Co.	Nevada, Mo.	672	(b) 672
New Jersey Zinc Co. of Penn.	Palmerton, Penn.	7,200	7,200
Oklahoma Spelter Co.	Kusa, Okla.	(j) 1,600	(h) 1,600
Owen Spelter Co.	Caney, Kan.	1,920	1,920
Pittsburg Zinc Co.	Pittsburg, Kan.	910	(h) 910
Prime Western Spelter Co.	Gas City, Kan.	4,866	4,866
Quinton Spelter Co.	Quinton, Okla.	1,340	2,016
Sandoval Zinc Co.	Sandoval, Ill.	672	(a)
Tulsa Fuel and Manufacturing Co.	Collinsville, Okla.	6,232	6,232
United States Smelting Co. (a)	Altoona, Kan.	4,600	4,640
United States Smelting Co.	Checotah, Okla.	4,480	5,120
United States Smelting Co.	La Harpe, Kan.	1,926	(g)
United States Zinc Co. (l)	Henryetta, Okla.	1,200	2,400
United States Zinc Co.	Sand Springs, Okla.	8,000	8,000
United States Zinc Co.	Pueblo, Colo.	1,984	2,200
United Zinc Smelting Corpn.	Moundsville, W. Va.	(d)	(m) 1,728
United Zinc Smelting Corpn. (i)	Clarksburg, W. Va.	3,648	3,648
Weir Smelting Co.	Weir, Kan.	448	(a) 448
Totals		212,614	217,194

(a) Closed during latter part of 1917. (b) No report received; entered the same as previous year. (c) Formerly Granby Mining and Smelting Co. (d) Under construction. (e) See Bartlesville Zinc Co. (g) Dismantled, end of 1917. (h) Idle all of 1917. (i) Formerly Clarksburg Zinc Co. (j) Idle latter part of 1916. (k) Absorbed by Kusa Spelter Co. (l) Formerly Western Spelter Co. (m) Not yet in operation.

hands of smelters. From this time the spelter market was a declining one, with only trifling, fitful advances.

After the middle of the year the weakness became pronounced. The situation was simple. Production was in excess of the demand, and the market was sold down to check production rather than to let stocks accumulate further. Thenceforward, spelter never touched 9c. again. Early in September the price was down to 7⅞c. Then it rallied to about 8⅛c., but at the end of October it was down to 7⅛c., rising to 7¼c. and closing the year at 7⅞ cents.

Early in the war the Government appointed a zinc committee, which discussed the arrangement of a price for Governmental purchases, but before any conclusion was reached the market price was below all the figures that were talked about and that were considered to represent a fair price on the basis of cost of production. The Government therefore obtained its supplies of common spelter by competitive offers in the old-fashioned way. Brass special and intermediate were obtained in a similar fashion. However, in the latter part of 1917 a new zinc committee was appointed, its purpose being mainly to arrange differentials between

EXPORTS DURING FIRST TEN MONTHS

	1915	1916	1917
Zinc ore, long tons	743	70	365 (d)
Zinc dross, lb	8,329,346	56,525	20,530,634
Pigs, bars, plates, sheets, etc.	128,735,815 (a)	.....	.....
Pigs, plates, slabs, etc.:			
From domestic ore, lb.	49,418,677 (b)	233,049,134	232,778,898
From foreign ore, lb. (c)	8,836,247 (b)	72,021,299	110,922,956
Sheets, strips, boiler plates, etc., lb.	19,605,612 (b)	24,202,936	25,225,287

(a) For six months, January to June, inclusive. On July 1, 1915, a change was made in method of classification. (b) Covers period beginning July 1. (c) Reported as exports of foreign merchandise prior to July, 1915. (d) Nine months only; October figures not yet received.

IMPORTS DURING FIRST TEN MONTHS

	1915	1916	1917
Zinc ore and calamine, gross weight, long tons	102,873	297,311	175,284
Zinc contents, lb.	81,355,750	252,951,201	135,668,774
Blocks or pigs and old, lb.	1,526,844	1,192,657	387,447
Zinc dust, lb.	1,337,127	1,686,665	732,647

common spelter and the other grades, especially high-grade, in which there is only small competition, so that they could be obtained on the competitive basis for common spelter. Up to the close of 1917 no specific arrangement of this nature had been consummated.

Zinc Mining in Wisconsin

BY J. E. KENNEDY*

The net tonnage of zinc ore shipped to smelteries from the Wisconsin district in 1917 increased 13% over that of 1916, as indicated in the accompanying table. The gross tonnage shipped from mines to smelteries and to separating plants increased 16 per cent.

Ore prices in 1917 opened at $75 per ton base for premium or best grade of zinc ore. The highest base price paid was $90, and this high figure prevailed for five consecutive weeks in the first quarter. The price fluctuated between $75 and $90 during the first six months of the year, but a general decline set in after July 1. The year's average base for premium grade was $74 per ton of 2000 pounds.

A total of 68 mills and nine roasters were in operation during 1917, as against 82 mills and 14 roasters in 1916. Eleven concentrating mills were built new or moved and reconstructed; namely, North Survey (Dodgeville), New Empire and New Rose No. 2 (Platteville), C. S. H. (Cuba City), Mud Range (Potosi), Copeland (Shullsburg), Jefferson (Hazel Green), Hird No. 3, Bearcat, Hoskins, and Ida Blende (Benton-New Diggings).

*Platteville, Wis.

Labor was generally scarce throughout the year, but more efficiency was developed than prevailed in 1916. Better housing facilities, provided by the larger companies, and maintenance of the high level of wages made men more contented with their jobs and less eager to change about. Shovelers at 8@11c. per can, under usual conditions, averaged $4@5 per day; underground drill men were paid $3.50@3.75 guarantee and averaged $4 with premium; trammers received $3 on straight wages and made $5 under contract; hoistermen were paid $3.75, grizzlymen $3, crusher feeders $2.75 and millmen $100@150 per month.

WISCONSIN ZINC-ORE SHIPMENTS

(First 11 Months of 1917)

	Net to Smelteries		Gross from Mines	
	1916 Tons	1917 Tons	1916 Tons	1917 Tons
Highland	3,678	4,508	3,831	4,508
Linden	3,118	1,454	13,384	15,751
Mifflin	4,692	3,042	28,111	37,081
Mineral Point	27,013	31,989	728	943
Montfort	1,587	689	1,836	971
Platteville	4,560	4,544	14,832	7,892
Dodgeville	421	320	496	1,250
Cuba City	19,691	21,994	3,946	689
Benton-New Dggings	38,261	57,053	85,407	116,089
Hazel Green	1,312	614	18,640	11,513
Shullsburg	704	4,881	7,629	10,611
Potosi	834	1,978	834	2,812
Galena (Ill.)	12,662	1,753	15,732	17,625
Dubuque (Iowa)	53	.....	53	.....
Totals	118,586	134,819	195,459	227,735
Increase	.....	16,233	.....	32,276

Reduced prices of ore, on the one hand, coupled with the high record prices of material and wages, discouraged prospecting. Few new companies were incorporated and many smaller operators were forced to discontinue business. More efficient methods of the larger operators were reflected in the increased production attained by the district, while the number of producing properties was materially reduced. The largest three operators, the Mineral Point Zinc Co., Wisconsin Zinc Co. and Vinegar Hill Zinc Co., produced 56% of the district's output of lead and zinc concentrates, each company contributing almost an equal amount of tonnage. The Frontier Mining Co., with five producing properties, was a close fourth in tonnage output.

Further macadamizing of country roads facilitated transportation. The three operators mentioned above built a standard-gage spur, 1¾ miles in length with 630 ft. of tunnel, costing approximately $75,000 and connecting the mines and the Skinner roaster at New Diggings with the Chicago & North Western Ry. at Strawbridge.

Lead and Zinc in the Joplin District

By Jesse A. Zook*

THE weekly average shipment of zinc concentrates from the Joplin district in 1917 was 8503 tons. In 1916 it was 7491 tons, and in 1915, 5973 tons. The incentive for increased tonnage from year to year originated in the high prices of June, 1915, and a large part of the 1917 production resulted from prospect work during the latter half of 1915. In 1917 the gain per week was 1012 tons over 1916, while the 1916 gain was only 518 tons per week over 1915 production.

Fewer large-capacity mills were begun in 1917, but a large number of mills were removed from one part of the district to another. At the close of the year, 50% of the mills were either removed or sold for removal from the "sheet ground" area extending from Duenweg northwest to Webb City, and from the small area west of Joplin.

TABLE I. ORE PRICES IN JOPLIN DISTRICT

(Per Ton of 2,000 Lb.)

	Zinc		Lead	
	High (a)	Average (b)	High	Average
1906	$54.00	$43.30	$87.00	$77.78
1907	53.50	43.68	88.50	68.90
1908	47.00	34.36	66.00	54.66
1909	55.00	41.08	60.50	54.56
1910	52.00	40.42	58.00	51.98
1911	51.00	39.90	64.00	56.76
1912	67.00	53.33	68.00	56.60
1913	59.00	42.26	58.00	52.52
1914	54.00	40.46	54.50	46.55
1915	138.90	79.30	80.00	55.08
1916	131.70	84.72	104.84	84.07
1917	101.95	67.70	135.50	98.00

(a) Highest settlement price recorded. (d) Derived from weekly settlement values.

Oklahoma marks a gain for 1917 over 1916 of 107,714 tons of zinc concentrates, Kansas a gain of 11,680 tons and Missouri a loss of 27,627 tons. The increased Oklahoma production resulted from the 1915 prospecting and 1916 developments from Commerce north to the Kansas state line, creating progressively the mining camps of Tar River, Cardin, Douthat, Century, Picher and St. Louis, in Oklahoma, and Treece, in Kansas. Picher took the lead and produced a typical frontier mining camp by the close of the year. It was founded upon the developments of the Eagle-Picher Lead Co., holders of several thousand acres of leased Indian lands. With not even a guaranteed surface right for any specific period, some substantial buildings were erected.

TABLE II. MONTHLY AVERAGE PRICES OF JOPLIN ORES

(Per Ton of 2,000 Lb.)

1917	Blende	Calamine	Zinc Ore All Grades	Lead
January	$78.12	$51.02	$76.86	$90.36
February	85.92	51.35	82.66	104.00
March	86.70	50.97	82.94	118.02
April	78.27	43.70	75.43	113.21
May	74.73	40.73	71.11	111.83
June	74.27	44.31	71.44	123.66
July	70.21	42.08	67.99	121.89
August	69.25	40.90	67.48	111.64
September	69.03	36.54	66.95	89.32
October	62.43	35.40	60.83	80.59
November	59.12	36.79	57.29	72.23
December	57.31	37.76	56.23	76.89

The increased Kansas production was from new territory north of the Oklahoma developments, in part, and from new territory west of Waco, Mo., in a newly prospected area. Most of the production of this area came from the Kansas side, the developments on the Missouri side not arriving at a producing stage until the year end. Waco is the logical center of this area, having steam and electric railway connection with Joplin to the south, and Pittsburg, Kan., to the north.

The zenith of shipments was reached the end of August, aggregating 14,500 tons of blende. At the end of November shipments had declined to only 7200 tons per week. Production during this period dropped from 12,000 to 8500 tons weekly.

*Joplin, Mo.

The year 1917 opened with blende selling up to $83 per ton. The price advanced to $101.95 by the end of February, dropping thereafter steadily to $75.40 at the end of April, and then advancing to $84.30 by the end of May, from which figure the decline was steady to $72.65 at the end of November. While the latter amount was paid for only a limited tonnage, the average mid-December price was $59.16 per ton. Calamine opened 1917 on a $50@45 basis for 40% Zn, advanced to $56@50 in March, receded to $40 in mid-May, went up the next week to $45@40, and that figure continued to mid-August when it dropped to $35@30. The next week the price moved up to $38@35 and this held to the year end.

Lead opened the year at $93.90, high, rose to $130 by the first of March, dropped to $113.70 in mid-April, advanced to $135.50 at the end of June, when there followed a gradual decline to $64.10 at the end of October, and an advance to $85.75 at the close.

TABLE III. JOPLIN DISTRICT ORE SHIPMENTS, IN POUNDS, 1917

Missouri	Blende	Calamine	Lead	Values
Jasper County	452,225,400	10,058,520	77,100,360	$21,746,730
Newton County	33,396,000	43,809,600	1,544,080	2,170,560
Lawrence County	7,026,550	12,185,520	787,480	539,150
Dade County	.....	2,304,810	.....	38,720
Christian County	.....	1,376,140	.....	29,310
Greene County	.....	1,192,600	.....	23,500
Howell County	.....	460,540	.....	8,220
Totals	492,647,950	71,387,820	80,031,920	$24,556,190
Oklahoma				
Ottawa County	317,516,270	135,870	56,709,600	13,351,600
Kansas				
Cherokee County	73,971,920	.....	8,251,250	3,139,440
Arkansas(a)	190,310	4,040,790	.....	79,380
Total 1917(b)	884,326,450	75,564,480	144,392,770	41,126,610
Total 1916	700,260,450	57,940,380	115,401,690	37,600,630
Increase 1917	184,066,000	17,624,100	28,991,080	3,525,980

(a) Ores settled for through Joplin agencies. (b) December estimated for each county.

Coal gondolas were pressed into zinc-shipping service in October and a shortage of cars tied up in the bins of producers upward of 30,000 tons of zinc concentrates by the end of November. On Dec. 7 a snowfall, unequalled in intensity and accompanying cold, covered the district. The average depth was given at thirteen inches, with drifts three to four feet deep. Electric interurban and city traffic was interrupted and many mines and all prospect and development work were at a standstill three to four days.

On Dec. 11 the freight management of the Frisco railway system was in conference with the *Journal* correspondent concerning the car situation, delving into details relative to the respective needs of producers in the several camps, and discussing how best to relieve the most urgent needs first.

Coal Production of the World

The United States in 1917 produced fully 45% of the world's output of coal, according to an estimate of the National City Bank of New York. This country has been the world's largest producer of coal for many years. In 1913, the latest normal year for world production, it produced 570,000,000 short tons against 322,000,000 in Great Britain; 306,000,000 in Germany; 60,000,000 in Austria-Hungary; 45,000,000 in France; 36,000,000 in Russia; 25,000,000 in Belgium and 24,000,000 in Japan. The total world product of 1913 was 1,478,000,000 tons, our share being approximately 38%. In 1916, our share of the world's product was about 44%. The coal production of the United States has grown from 270,000,000 short tons in 1900 to almost 650,000,000 short tons in 1917. According to the bank's statement, the United States' coal supply far exceeds that of any other country, being estimated at 3,527,000 million short tons, against 180,000 million in Great Britain and 164,000 million in Germany. China is said to contain 1,500,000 million short tons, but so far has produced but little, the 1913 output being but 15,432,000 short tons.

Great Britain's coal exports in 1913, the latest normal year, amounted to 82,000,000 short tons and Germany's to about 37,000,000 short tons, while the United States in the fiscal year 1913 exported but about 23,000,000 short tons. Since the beginning of the war, however, our coal exports have shown a slight increase, having been about 20% more in 1917 than in 1913, while those of Great Britain meantime declined and those of Germany were, of course, confined to trade with the adjacent neutral countries. Of the coal exported from the United States in the fiscal year 1917, about 68% went to Canada, 6% to Cuba, 8% to South America and less than half of 1% to Italy.

British Aluminum Co. Planning To Enlarge Plant

The increased demand for aluminum due to the growth of the aircraft industry and of other branches of manufacture has caused the British Aluminum Co. to take steps to enlarge its plant in Scotland, according to the London *Times* Engineering Supplement. The principal factories of the company are at Foyers and Kinlochleven. The hydro-electric plant at the latter place is even now the most important in Great Britain and will be greatly enlarged by the proposed scheme. The watershed that is to be drawn upon includes that known as Laggan and Ossian and a portion of the Ben Nevis area. The sanction of Parliament is being sought for the construction of nine works.

The main features of the scheme comprise two dams. One is to be across the River Spean, near Roughburn, at a point above its union with Loch Treig, and will be about 700 ft. long and 100 ft. high; while the second dam, planned for impounding the waters of Loch Treig, will be about 600 ft. long and 30 ft. high, and will cut the stream joining Loch Treig with Idir Loch. Five conduits are to be built. The one connecting Lock Treig with the Kinlochleven factory is to be 12 ft. in diameter, and that between the River Spean dam and Loch Treig will be a 10-ft. tunnel.

The level of Loch Treig will be raised about 40 ft. by the proposed changes, but it is thought unnecessary to change the level of Loch Laggan. The company is seeking powers to regulate the level of seven other streams also. The acreage of land which will be submerged is comparatively small, and is largely rough moorland. The new power house will be on a site between the River Leven and Kinlochmore, and from the terminus of the tunnel there a light railway will give communication with the company's property. The proposed works probably will not be completed in less than five years after the placing of contracts. The decision to raise the level of Loch Treig would necessitate the diversion of a small length of the North British Railway.

Iron and Steel

THE steel industry of the United States in 1917 not only surpassed its production in 1916, but was also distinguished by the manner in which the resources of the iron and steel trade were placed at the disposal of the Government and every effort expended toward coöperation. With preference given to Government orders, and the agreement which was entered into in September whereby the prices of steel products were fixed by the War Industries Board and the manufacturers, the dominating influence of the Government had a stabilizing effect. The manufacture of ship steel was probably the greatest new physical development that occurred in the steel trade in 1917, the increased demand for ship steel being stimulated by the expansion of shipyards to rush construction work.

Lake Superior ore shipments for 1917 were 62,499,099 tons, a decrease of 2,235,099 tons from 1916, when the record shipment of 64,734,198 tons was made. Rail

TABLE I. LAKE SUPERIOR IRON-ORE SHIPMENTS

	1915	1916	1917
Escanaba	5,649,289	7,457,444	7,157,054
Marquette	3,099,589	3,858,092	3,207,145
Ashland	5,146,772	8,057,814	7,597,841
Two Harbors	8,642,942	10,735,853	9,990,990
Superior	8,342,793	12,787,046	13,978,730
Duluth	15,437,419	21,837,949	20,567,419
Totals by lake	46,318,804	64,734,198	62,499,099
Totals all rail (est.)	953,947	1,924,268	2,283,810
Total shipments	47,272,751	66,658,466	64,782,909

shipments for 1917 increased and may approach 2,500,000 tons when the final figures are out, most of which was shipped to the Minnesota Steel Co. at Duluth.

Late opening of the Lake shipping season, a shortage of boats and the prevailing car shortage appeared to offer a curtailment of ore movement early in the season, but, through the intervention of the Government and coöperation with the furnacemen, sufficient tonnages were secured. Ore prices were: Old Range bessemer, $5.95; Mesabi bessemer, $5.70; Old Range nonbessemer, $5.20 and Mesabi nonbessemer, $5.05 per ton.

Vessel freights, which in 1916 were from 45 to 60c., increased to 85c. and $1.10, and later a further advance was made and rates as high as $1.50 were paid. Rail-

TABLE II. PIG-IRON PRODUCTION BY HALF-YEARS

(In Long Tons)

	1914	1915	1916	1917
First half	12,536,094	12,233,791	19,619,522	19,258,235
Second half	10,796,150	17,682,422	19,815,275	19,109,618
Year	23,332,244	29,916,213	39,434,797	38,367,853

TABLE III. PIG-IRON PRODUCTION FOR 15 YEARS

(In Long Tons)

1903	18,009,252	1908	15,936,918	1913	30,966,152
1904	16,497,003	1909	25,795,471	1914	23,332,244
1905	22,992,380	1910	27,303,567	1915	29,916,213
1906	25,307,391	1911	23,649,547	1916	39,434,797
1907	25,781,381	1912	29,726,937	1917 (a)	38,367,853

(a) December production estimated.

TABLE IV. PIG-IRON PRODUCTION BY GRADES

Grades	1916 Long Tons	1916 %	1917 (a) Long Tons	1917 (a) %
Basic	17,684,087	45.0	17,188,798	44.8
Bessemer	14,422,457	36.5	14,042,634	36.6
Foundry	5,533,644	14.0	5,179,660	13.5
Malleable	921,486	2.3	997,534	2.6
Forge	348,344	0.9	383,678	1.0
Spiegeleisen	186,990	0.5	157,310	0.4
Ferromanganese	228,544	0.6	268,575	0.7
All other	89,245	0.2	149,634	0.4
Totals	39,434,797	100.0	38,367,853	100.0

(a) Estimated.

roads were allowed a 15c. increase by the Interstate Commerce Commission, so that during 1917 rail freights were from 50c. to $1.50 per ton.

Mine operators contend that ore prices are too low when based on price of pig iron, as specified by the Government, but no change will be made before the beginning of the second quarter.

Production of pig iron in 1916 was 39,434,797 gross tons, and in 1917 about 38,750,000 tons. Production of steel ingots was 41,401,917 gross tons in 1916 and about 42,500,000 tons in 1917. Some pig iron stocks were used in 1917, and there was doubtless a decrease in the consumption of pig iron by foundries. The production of finished rolled steel in 1916 was 30,557,818 gross tons, and in 1917 about 31,500,000 tons.

Pittsburgh Iron and Steel Markets

BY B. E. V. LUTY*

THE iron and steel market underwent unusually complicated changes in 1917. It was not a simple case of price advances and declines, although there were both, nor yet a matter of variation in the volume or general character of the demand. The circumstances under which business was transacted underwent the most radical mutations.

The sharply advancing tendency that was resumed about Aug. 1, 1916, after three months of approximately stationary prices, continued without material change in character during January. Then came Germany's declaration, on Feb. 1, of ruthless destruction of merchant shipping by submarines. The steel market has always been one of kaleidoscopic changes, and that circumstance has trained both buyers and sellers to be keen to appraise the importance and bearing of developments. While there may have been doubts in many quarters, in the iron and steel trade there was one common view, that Germany's declaration meant war.

Iron and steel prices at once began to rise still more sharply. Steel producers had been claiming in 1916 that they had not advanced prices; that buyers had bid them up. However that may be, the honors may as well be shared, there being plenty for both parties. Quotations rose sharply in February and March, and with the declaration of war on Apr. 6, 1917, they simply continued to rise. Using a weighted average of the principal finished-steel products, and the low point in the market of December, 1914, as base, steel products were at 2.5 prices on Jan. 1, at 2.9 prices Apr. 6 and at 4.1 prices at the beginning of July. That was the top point, there being a slight recession up to the inception of Government price-fixing, which eventually established a

*971-3 Union Arcade, Pittsburgh, Penn.

set level at 2.7 prices. Using another basis of comparison, the set prices were 2.1 times the average quotations in the 10 years ended 1913—barely double those actually paid in the period, as the highest quoted prices had not been paid on any considerable tonnages.

In April there was a total change in the character of the market. Previously, regular contracting had been done, for such forward deliveries as the large mills could make, and the small mills, which do not customarily sell far ahead, but rather depend upon the prompt market, and frequently secure premium deliveries, had been demanding a premium. In April the large mills practically withdrew from the market. Thereafter they did not advance prices, while the small mills continued to make advances. Probably the large mills did take some new business thereafter, at their last official figures, but they did not quote openly any prices at all.

Thus the market worked itself into an impossible position. The prices that were quoted as "the market" on July 1 were in essence premium figures, although they were the only ones openly quoted. The great bulk of the deliveries being made were based on selling costs approximately half as high. Obviously, consumers could not afford to pay such high premiums on all their purchases, and the inflated market would last only as long as the famine lasted, perhaps for a few months, perhaps to the end of the war.

On July 12, President Wilson appealed to miners and manufacturers that they "forego unusual profits" and that there should be "one price for all," the Government, its Allies, and the general public. He insisted that the war requirements were varied in character and that no clear line could be drawn between what was war material and what was peace material; that, indeed, all the resources of the country should be used for prosecuting the war. He did not refer to steel in particular or to any specific commodity.

The steel industry was not ready, at the moment, to subscribe to the doctrine, and the issue dragged for some time. It became so clear, later in the year, that President Wilson was exactly right, as regards iron and steel, that it may well be assumed the iron and steel industry realized that the "one price for all" arrangement would have to be made sooner or later, and merely wished to delay the settlement while the peace consumers were taking their steel so freely. The orders of the Government were accepted either at special prices agreed upon from time to time, or subject to a set price to be developed later. At a meeting in Washington between the War Industries Board and the iron and steel manufacturers, held on Sept. 21, an agreement was reached that there should be one price for all and that a general schedule should be developed which should be in proper relation, as to cost of manufacture, etc., with certain basis prices, then and there agreed upon, viz.: Lake Superior iron ore, no change; pig iron, $33 per long ton; bars, 2.90c. per lb.; shapes, 3c.; plates, 3.25c. Prices for other commodities were subsequently set by the War Industries Board, and then, at the board's invitation, other commodities were given set prices by the American Iron and Steel Institute. It should be mentioned that the figures agreed on do not apply on export sales of material not involved in the war.

No data have been available as to the tonnages of steel ordered by the Government, a rule having been made that such information should be withheld. The orders up to the end of September may have been more or less than a million tons. Thereafter they became much heavier, particularly so as the Government then began buying for its Allies also. The exact amount of steel ordered by the Government, however, would not furnish any definite indication as to the war's real demands upon the iron and steel industry, for two reasons: (1) Deliveries against these orders are according to the Government's desires, subject to mill possibilities, so that the rate of delivery at any one time could not be determined for comparison with the total rate of production at the time; (2) steel is required by various industries whose activity contributes more or less directly toward prosecuting the war, and these industries, if necessary, can call upon the Government for support in securing deliveries.

The prospect at the close of 1917 was, indeed, that little steel would be used for ordinary commercial purposes not connected with the war. Ordinary building activities had dropped to a low ebb. The production of passenger automobiles had greatly decreased, while, on the other hand, the Government had ordered 30,000 three-ton motor trucks. Scarcely any orders for cars or locomotives had been placed by domestic roads for several months, and the railroads were awaiting Government action, and probably Government financing, as to further increases in their facilities, when President Wilson's proclamation of Dec. 26, by the terms of which the Government took over the operation of all the nation's railroads, including auxiliary water lines, clarified the situation and established a basis for a clear understanding as to the future of the roads.

AVERAGE PRICES OF PIG IRON AND STEEL AT PITTSBURGH, 1917

	Pig Iron			Steel Products							
	Bessemer	Basic	No. 2 Foundry	Ferromanganese	Bessemer Billets	Beams	Plates	Bars	Black Sheets No. 28	Pipe, Basing Discount	Wire Nails Base
January	$35.95	$30.95	$30.95	$175.00	$63.50	3.11c.	3.61c.	3.00c.	4.50c.	64%	$3.00
February	36.37	30.95	30.95	210.00	65.00	3.25	3.75	3.00	4.63	62½	3.00
March	37.37	33.49	35.91	270.00	68.00	3.52	4.33	3.27	4.90	60½	3.18
April	42.28	38.95	40.11	325.00	75.00	3.70	4.50	3.39	5.88	55	3.28
May	46.94	42.84	43.60	400.00	88.00	4.00	4.50	3.64	6.73	49	3.50
June	54.22	50.10	47.45	400.00	95.00	4.25	7.10	4.00	7.50	49	3.71
July	57.45	53.80	53.95	400.00	95.00	4.50	9.00	4.50	8.00	42	4.00
August	54.17	50.37	53.95	375.00	84.00	4.50	8.96	4.50	8.00	43½	4.00
September	46.40	42.29	48.63	360.00	70.00	4.06	7.05	3.88	8.00	49	4.00
October	37.25	33.95	33.95	300.00	55.25	3.00	3.25	2.90	7.32	49	4.00
November	37.25	33.95	33.95	250.00	47.50	3.00	3.25	2.90	5.06	50½	3.58
December	37.25	33.95	33.95	245.00	47.50	3.00	3.25	2.90	5.00	51	3.50
Year	$43.59	$39.63	$40.61	$309.17	$71.16	3.66c.	5.21c.	3.49c.	6.29c.	52½%	$3.56
Year 1916	23.88	20.98	21.11	166.72	44.23	2.50	2.82	2.48	3.06	70¼	2.53

Prices of pig iron, ferromanganese and billets are per long ton, 2,240 lb.; of steel products, per lb.; of nails, per 100 lb., base; of pipe, in discount on base sizes, ¾ to 2 in., from a list per foot equivalent to 10c. per lb.

Government prices announced: Sept. 24, pig iron, beams, plates and bars; Oct. 11, billets; Nov. 5, sheets, pipe and wire.

Iron Mining in the United States

IRON mining in the United States in 1917 was active in response to the heavy demands for the ore throughout the year, but shipments were less than in 1916, because abnormal conditions curtailed the movement from the Lake Superior districts. This decrease was caused by a late opening of the shipping season, which prevented free dispatch of boats before June 15, and by the scarcity of vessels necessary to move the ore. Excellent conditions prevailing in November permitted record shipments from the Lake Superior district in that month.

The activities of the I. W. W. at the Lake Superior mines led to slight disturbances on the Cuyuna and Gogebic ranges, but both were of small consequence. Legislation bearing on the iron industry in the Lake Superior region consisted of the passing of a bill in Minnesota providing a fund of $50,000 per year for the suppression of emergency disorders, and the defeat of the tonnage or super tax, which imposed a 2% ad valorem levy on iron mined in that state, in addition to all other taxes. Ore shipments down the Mississippi were initiated.

Mesabi Range Adopts Labor-Saving Devices

Wages on the Mesabi range reached the highest point, common labor receiving $3.60 per day toward the latter part of 1917, and some of the contract miners getting as high as $7. The shortage of labor, even at these prices, led to some of the properties that ordinarily would be mined underground being operated as openpits, as this process requires fewer men. This condition also stimulated the adoption of several labor-saving devices. Among the latter were: In the openpits, 300-ton revolving shovels, which require less track laying; 20-yd. steel automatic air-dump cars, in place of 8-yd. hand-dump cars; air-actuated spreaders for leveling off dumps; air drills, in place of hand drills, for drilling ore in pits; air tamping machines for tamping ties. In underground mines, one-man air drills were used, Hoar and Middlemiss shoveling machines were being tried out and other types were being developed.

Several properties formerly operated by the Arthur Mining Co., a subsidiary of the Great Northern R.R., were leased on a royalty basis to the Todd-Stambaugh Co., Pickands-Mather Co., M. A. Hanna Co., Jones & Laughlin Co. and Butler Bros. Stripping operations were conducted at Washoe mine, at Coleraine; Majorca mine, at Calumet; Patrick, Kevin, Ann and York mines, at Nashwauk; Bennett mine, at Keewatin; Warren mine, at Carson Lake; Webb mine, at Hibbing; Missabe Mountain, at Virginia; Fayal, Jean, Rutland, Leonidas, Adams and Spruce mines, at Eveleth, and St. James, at Aurora. Shaft sinking was carried on at the Carson Lake, Albany and South Agnew, at Hibbing. Two new mines were developed at Grand Rapids by the Newport Mining Co., new operators in this field. New construction work included washing plants and rock-screening plants. Power lines operated by the Great Northern Power Co. were extended. Operations on the Vermilion range were characterized by activity in underground development work, and considerable exploration done.

Operations on the Cuyuna range of Minnesota were active, owing to the demand for manganiferous iron ores, and considerable drilling was done. Shaft sinking was carried on at the Rowe, Mille Lacs and Feigh mines, and the Barrows shaft, which had been idle for three years, was unwatered. Among the new shippers in 1917 were the Joan, Barrows, Feigh and Rowley mines. Scarcity of labor, due partly to the number of men entering Government service, resulted in a lowering of efficiency in various organizations. No difficulty was encountered in securing markets for the ore, but removal from the mines was hampered by lack of boats, although there was no shortage of cars and the railroads handling the ore between the mines and the docks gave excellent service. No further advances were made in benficiating Cuyuna ores in 1917, although there was increased activity and experimentation in that direction.

Few New Shippers in Michigan and Wisconsin

In the Michigan and Wisconsin districts the mines were active, but few new properties were opened up. Wages advanced similarly with those on the Minnesota ranges, but no labor troubles developed except a slight disturbance by the I. W. W. on the Gogebic range. In the Gwinn district of the Marquette range, the Cleveland-Cliffs Iron Co. installed new pumping equipment, but this proved inadequate toward the latter part of the year, when excessive amounts of water compelled the cessation of mining at the Stephenson and other mines. On the Gogebic range the Plymouth mine, which first shipped in 1916, was a large producer. Among new shippers in 1917 were the Spies mine and Hill Top and Victoria mines, on the Menominee range, and the Athens, on the Marquette range.

Old Mines Reopened in Birmingham District

In the Birmingham district iron mining was affected by shortage of labor, which was somewhat relieved toward the latter part of 1917 by the return of some of the negro laborers who had been attracted north by high wages and by the influx of farm laborers. Wages increased, and toward the end of the year were 40% higher than in 1916. High prices paid for ores resulted in the reopening of many old mines in the region, particularly in Franklin County.

In New York, properties near Mineville were active in 1917. Other producers were the Forest O'Dean mine, at Fort Montgomery, and the Sterling mine, at Sterlington. Comparatively little development is reported from iron mines in Virginia, and the production of hydroxide ores in the Shenandoah Valley and limonite ores in the New River-Cripple Creek district, formerly active, was small. Large deposits of magnetite are reported as available in Piedmont County, but no mining has yet been done there. In New Jersey and Pennsylvania, several old properties were reopened; the operations of the Empire Steel and Iron Co. at Mt. Hope and Oxford, N. J., were extensive and considerable magnetite was mined. In the intermountain region, the Colorado Fuel and Iron Co. operated its mines in Sunrise, Wyo., and Fierro, N. M. In California some exploration and mining of iron ores was undertaken by the Noble Electric Steel Co., but most of its efforts were directed toward the production of ferroalloys.

Ferromanganese and Spiegeleisen

BY GEORGE C. STONE*

THERE has been a marked change in the relative amounts of ferromanganese and spiegeleisen used by the steel trade. Table I shows the imports and production for three successive periods of five years each, also the steel made, the proportion of manganese to steel and the proportions of total manganese supplied by spiegeleisen and ferromanganese.

Imports of spiegeleisen have almost ceased and the production decreased over 40%, while the imports of ferromanganese were larger in the last two periods and the domestic production increased nearly 200%. Steel production for the three periods increased in the ratio 100: 126: 184, with a decided reduction in the relative amounts of manganese, a ratio of 100: 91: 86. In the first period, 40% of the manganese was supplied by spiegel and 60% by ferro; in the next period, 24.22% by spiegel and 75.8% by ferro, while in the last one 11.4% was from spiegel and 88.6% from ferro.

SPIEGELEISEN USED WITH BESSEMER, FERROMANGANESE WITH OPENHEARTH PROCESS

Statistics of production show that there was no material increase in the proportion of manufactured soft steel, which would be an obvious reason for the increase in the relative amount of ferromanganese used. The accompanying chart shows the proportion of the total steel made by the bessemer and openhearth process and the proportion of the manganese used derived from spiegeleisen. The decrease in the proportion of bessemer is closely paralleled by the decrease in the proportion of the manganese derived from spiegeleisen.

TABLE I. DATA ON FERROMANGANESE, SPIEGELEISEN AND STEEL (a)

	1902–1906 Tons	%	1907–1911 Tons	%	1912–1916 Tons	%
Spiegeleisen imports	348,176	26.5	116,850	12.7	4,162	0.7
Spiegeleisen production	960,255	73.5	800,928	87.3	578,506	99.3
Total spiegeleisen available	1,308,431	100.0	917,778	100.0	582,668	100.0
Ferromanganese imports	250,920	49.5	415,439	56.2	456,395	38.7
Ferromanganese production	255,269	50.5	324,627	43.8	722,069	61.3
Ferromanganese available, total	506,189	100.0	740,066	100.0	1,178,464	100.0
Manganese in spiegeleisen	235,518	39.9	165,200	24.2	104,880	11.3
Manganese in ferro	354,332	60.1	518,046	75.8	824,925	88.7
Manganese total	589,850	100.0	683,246	100.0	929,805	100.0
Steel produced	87,764,198		111,111,897		160,969,923	
Percentage of manganese used to steel produced	0.672		0.615		0.577	

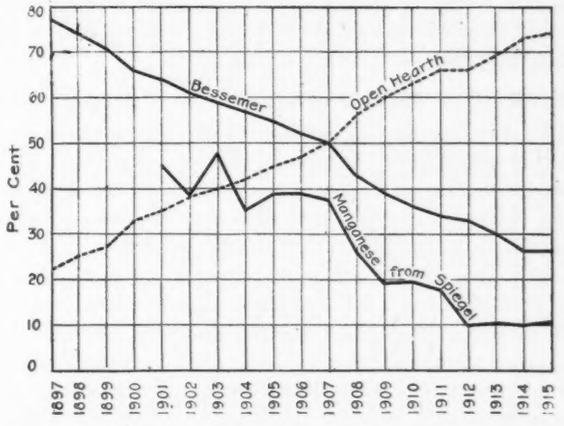
(a) The manganese is calculated on the assumption that the spiegeleisen averaged 18% and the ferro 70%.

In the bessemer process the heats are short and the time of completion is known almost to the minute. Under these conditions, spiegel can be melted in a cupola without unreasonable losses. During the time that the bessemer converter was the principal source of steel, spiegel was largely used.

In an openhearth furnace the duration of a heat is uncertain and so irregular that it is often impossible to have spiegel melted and ready at the termination of the heat. With the increasing use of the openhearth it therefore became common practice to use ferro, as the smaller quantity required could be placed in the ladle and melted by the steel. Where relatively hard steel was desired, liquid pig iron was added to give the required amount of carbon (in excess of that carried by the ferro) needed to release the manganese.

ECONOMY IN USE OF FERRO AND SPIEGEL DEPENDS ON PIG-IRON PRICES

Two forms of practice were then common. In one, spiegel was added to give both manganese and carbon and in the other ferro was added to give manganese and part of the carbon and pig iron to supply the balance. Some works use spiegel by melting it in the ladle. With a "hot" heat, this can be done without trouble. It is, however, necessary to have some ferro on hand for use with the "cold" heats that are occasionally made. The relative economy of the two methods depends on the prices of pig iron, ferromanganese and spiegeleisen.



COMPARISON OF BESSEMER AND OPENHEARTH STEELS AND PER CENT. OF MANGANESE FROM SPIEGEL

However, it is easier for the steel maker to use ferro always, and in most cases he does, regardless of cost.

In general, while the prices of pig iron, ferromanganese and spiegeleisen rise and fall together, the changes are seldom proportional and the price of pig iron must be taken into account, as the proportion of iron in spiegel is much larger than in ferro. The price of pig iron is always known and with the price of either spiegel or ferro also known, the relative value of the other can readily be calculated. By relative value is meant the prices for the alloys that will give equal amounts of available manganese for the same cost. The calculations in Tables II and III assume that alloys

TABLE II. VALUE OF SPIEGEL ON BASIS OF FERRO AND PIG-IRON PRICES

Per Cent. Mn. in Spiegel	Base 80% Ferro at $50, Pig at $10	Add or Subtract for Variation of $1 in Ferro Price	Add or Subtract for Variation of $1 in Pig Price
70	$44.92	$0.8747	$0.1199
60	39.87	0.7498	0.2375
50	34.81	0.6250	0.3563
40	28.03	0.4851	0.4773
30	23.14	0.3633	0.5946
20	18.26	0.2425	0.7136
10	13.38	0.1213	0.8318

For instance: When ferromanganese is $275 and pig iron $36.30, what is the value of 20% spiegel

Base	$18.26
$225 increase in ferro at 0.2425	54.56
$26.30 increase in pig at 0.7136	18.77
Value of 20% spiegel	$91.59

*Chief metallurgist, New Jersey Zinc Co., 55 Wall St., New York.

carrying 40% or less manganese will be remelted at a cost of $1 per ton, with a loss of 3% of the manganese. Alloys containing more than 40% manganese will not be remelted.

The prices paid for spiegel and ferro are frequently out of proportion, as shown in Table IV, which gives the quoted prices for ferromanganese and pig and the calculated values of spiegel for the years 1907 to 1916.

TABLE III. VALUE OF FERRO ON BASIS OF SPIEGEL AND PIG-IRON PRICES

Per Cent. Mn. in Ferro	Base 20% Spiegel at $20, Pig at $10	Add or Subtract for Variation of $1 in Spiegel Price	Add or Subtract for Variation of $1 in Pig Price
80	$57.17	$4.1240	$2.9430
70	51.19	3.6075	2.4556
60	45.25	3.0924	1.9693
50	39.30	2.5775	1.4831
40	31.51	2.0000	0.9503
30	25.75	1.4981	0.4750
10	14.25	0.5001	0.4750

For instance: What is 80% ferromanganese worth when 20% spigel is $91.59, and pig iron, $36.30

Base	$57.17
$71.59 increase in spiegel price at $4.124	295.24
	$352.41
$26.30 excess in pig price at $2.943	77.40
Relative value of 80% ferro	$275.01

During a large part of that time, spiegel was sold for less and sometimes much less than these prices. Those who have used spiegel have found it profitable to continue the practice.

Rigid Requirements Demanded by Steel Makers

The steel maker is unreasonable not only in disregarding the relative values of the two alloys but he objects to buying any spiegel that does not contain either 10 or 20% manganese, and demands unreasonable concessions in price for intermediate grades. I know of many cases where the steel makers have refused to pay more for 23 or 25% spiegel than for 20%. In one case a steel mill was buying 10 and 20% spiegel from the same furnace company, which, it was learned, was mixing them to give a 15% product. When this mill was offered 15% spiegel it refused to pay more for it than for 10 per cent.

The phosphorus limits set for spiegel are severe and strictly enforced. As a matter of fact, 0.10% phosphorus in the spiegel is as little as will show a recognizable amount in the steel. With the usual proportion of 5% spiegel, this would give only 0.005% in steel, which is the limit of accuracy in ordinary works' analysis. I have known steel mills that regularly reported about 0.05% less phosphorus in spiegel than it actually contained, although it did not affect the quality of the product in the least. The same mill, however, would have rejected spiegel containing much less than this amount over the guarantee.

TABLE IV. PRICES OF FERRO AND PIG IRON WITH SPIEGEL EQUIVALENT

Years	Baltimore Prices 80% Ferro	Pittsburgh Prices Bessemer Pig	Equivalent Value 20% Spiegel
1907	$62.75	$21.74	$29.73
1908	44.31	16.14	21.26
1909	42.73	17.45	21.81
1910	40.49	17.12	21.04
1911	37.25	15.73	19.26
1912	50.40	16.01	22.65
1913	57.87	17.11	25.24
1914	55.80	14.90	23.17
1915	92.21	15.79	32.63
1916	164.12	23.85	55.81

The same things are true of ferromanganese. The steel maker can be persuaded to take 60%, but the only grades he wants are 70 and 80% and there are frequent cases of rejections where the grade was close to the limits. A maximum variation of 2% either way is frequently insisted on.

The requirement of extreme uniformity and purity was, perhaps, excusable before the war when the supply was ample, for it saved trouble in the steel works and the additional cost was not serious. In 1913, the last year before the war, 31,300,874 tons of steel were produced and 193,170 tons of manganese used. In 1916, 42,773,680 tons of steel were made and 253,643 tons of manganese used.

The imports of spiegel are negligible. The production in 1916 was double that in 1915, but only about two-thirds of the previous maximum, while ferro imports maintained the average rate of the previous seven years. Ferro production in 1916 was 48% greater than in the previous year, which was the largest on record.

It is probable that the next few years will show a further increase in the production of steel and consequently in the demand for manganese. If this is to be met, the steel makers will have to take whatever grades the available ores will make and pay prices equivalent to those they paid for the preferred grades.

The supply of ores necessary to make 80% ferromanganese is extremely limited. The ratio of manganese to iron must be $6\frac{1}{2}:1$ when the silica equals $\frac{1}{10}$ the sum of the iron and manganese and the ratio must be $7\frac{1}{2}:1$ when the silica equals 0.46 of the iron and manganese. Table V gives the approximate results that may be expected from ores of varying compositions.

TABLE V. MANGANESE IN ALLOYS FOR CORRESPONDING RATIOS OF IRON, SILICA AND MANGANESE IN ORES

Ratio in Ores, Mn : Fe	Composition of Alloys: 4% SiO_2 Relative Make	4% SiO_2 % Mn	12% SiO_2 Relative Make	12% SiO_2 % Mn	20% SiO_2 Relative Make	20% SiO_2 % Mn
1 : 3	100.0	20.7	72.4	17.8	52.6	14.0
1 : 2	99.7	28.2	72.1	25.5	52.2	21.9
1 : 1	99.1	43.8	71.6	41.6	51.7	38.7
2 : 1	97.9	59.8	70.5	58.3	50.8	56.1
3 : 1	96.1	67.9	69.0	66.6	49.5	64.9
4 : 1	94.0	72.7	67.4	71.6	48.2	70.1
5 : 1	91.9	75.9	65.7	74.9	46.8	73.6
6 : 1	89.7	78.2	63.9	77.3	45.4	76.0
7 : 1	87.5	79.9	62.2	79.0	44.3	77.8

Most of the available ore has a ratio of iron to manganese other than that which will give the grades most in demand. Much of it is siliceous and much is high in phosphorus so that the demand for extreme freedom from phosphorus unduly restricts the salability of available ores. The demand for close adherence to certain arbitrary percentages of manganese also restricts the supply of ores and decreases the output of manganese alloys. No ore is absolutely uniform and no furnace works with absolute uniformity. If only certain grades are salable the furnace manager "plays safe" and runs his furnace with a large margin of safety on quality to avoid making grades that must be either remelted or sold at a relatively lower price. In some cases, if he finds he can make an alloy slightly above the desired limit and receives no more for it, he increases his burden and drives harder, making more product but wasting manganese.

Lower grades will have to be used, as not only is there a scarcity of ore suitable for making the high grades, but, in making them, losses of manganese are larger and the capacity of a furnace is reduced. Specifications should allow the greatest possible latitude in grade and the maximum phosphorus that can be used without injury to the product. Academic purity and the convenience of the users must be disregarded if we are to get a sufficient supply of manganese ores, for which we know no substitute.

Chronology of Mining for 1917

JANUARY

Jan. 1—Reorganized "Ohio Copper Co., of Utah" resumed operation on company account, of Ohio mine in Bingham Canyon.

Jan. 3—Three men killed in Pittsburgh-Idaho mine at Gilmore, Idaho, by explosion on 400 level; 10 others temporarily entombed rescued the following day.

Jan. 4—United Eastern's 200-ton mill in the Oatman gold camp in Arizona began operation.

Jan. 8—Electrolytic Zinc Co. of Australia began construction of new electrolytic zinc plant near Hobart, Tasmania.

Jan. 14—Mexican decree, embodying forfeiture of idle mining properties, extended to Feb. 14; further postponement asked by United States Government.

Jan. 15—Dissolution of Pilot-Butte Mining Co. ordered by court, assets having been purchased by Anaconda.

Jan. 16—Labor strike at New Cornelia Copper Co.'s new leaching plant at Ajo, Ariz., practically ended by structural steel workers returning to work, repudiating jurisdiction of International Union of Mine, Mill and Smelter Workers.

Jan. 17—Lead shipped from St. Louis in the first half of November had not yet been received in New York, this reflecting the freight congestion of the time: normal transit from St. Louis to New York is about two weeks.

Jan. 20—First section of Consolidated Coppermines Co.'s 500-ton flotation mill started at Kimberly, Nev.—Machinery "turned over" at new electrolytic zinc plant of Judge Mining and Smelting Co., near Park City, Utah.

Jan. 24—End of two-weeks strike at Perth Amboy plant of American Smelting and Refining Co.

Jan. 29—Calumet & Arizona Mining Co.'s stock listed on New York Stock Exchange.

Jan. 30—Art. 33 of new Mexican constitution, requiring foreigners to renounce nationality and treaty rights before acquiring property, withdrawn for reconsideration.

FEBRUARY

Feb. 1—Leasing system re-established at Goldfield Consolidated Mines Co., Goldfield, Nev.

Feb. 2—British Ministry of Munitions ordered that no person should deal in lead except under license—Suit filed against Tennessee Copper Co. and National Surety Co. by Russian government for $1,140,000 advanced on trinitrotoluol purchase.

Feb. 13—Price of silver reached 79c. per oz., highest price since June, 1893.—Smeltery of Mason Valley Mines Co. at Thompson, Nev., resumed operations.

Feb. 15—Cerro de Pasco Copper Corporation stock listed on New York Stock Exchange.

Feb. 19—Smelting resumed in Mexico by American Smelting and Refining Co. at Monterrey, Nuevo Leon.

Feb. 25—Snowslide at Federal Mining and Smelting Co.'s North Star mine, 12 miles northeast of Hailey, Idaho, struck compressor house and bunkhouse, killing 16 men.

MARCH

Mar. 1—Star Mining Co. filed suit for $500,000 against Federal Mining and Smelting Co. for alleged ore trespass through latter's Morning mine in Cœur d'Alene district, Idaho—Increase of 25c. per day in wages made by Park City, Utah, mines as a result of the high prices for lead and silver—In the Cœur d'Alene district of Idaho, another increase of 25c. per day was made effective while lead remains at or above 7½c. per lb., total bonus now being $1.25 per shift.

Mar. 6—Price of lead in New York touched 9½c. per lb., being the highest since Civil War times.

Mar. 8—E. P. Mathewson awarded 1917 medal of Mining and Metallurgical Society of America, for distinguished service to the industry.—Mazapil Copper Co. resumed smelting operations on small scale at its works in Coahuila, Mexico.

Mar. 12—First train of ore hauled from Goodwin, terminus of new Deep Creek railroad in western Utah.

Mar. 13—Capitalization of Copper Queen Consolidated Mining Co., of Bisbee, Ariz., increased from $2,000,000 to $50,000,000 and name changed to the Phelps Dodge Corporation, after having taken over the properties of Phelps, Dodge & Co.

Mar. 14—Termination of extension period for forfeiture of Mexican mining properties unoperated or which failed to request exemption because of impossible operating conditions.

Mar. 15—Old Dominion Co. of Maine succeeded Old Dominion Copper Mining and Smelting Co., a New Jersey Corporation, and will henceforth operate the Old Dominion and the United Globe mines at Globe, Ariz.

Mar. 16—Tamarack shareholders voted to sell their holdings at $60 per share to Calumet & Hecla Mining Co., giving latter complete control of this old Michigan copper mine.

Mar. 17—Eden Mining Co., Tonopah Mining Co., a subsidiary in Nicaragua, began milling its gold ore at initial capacity of 150 tons daily—First ore from 2700-ft. level on Comstock Lode, Nevada, mined during this week from old Consolidated Virginia mine; lowest mining in "bonanza days" was on 2500-ft. level.

Mar. 21—Leading copper mines of the United States offered Government about 50,000,000 lb. of copper at 16⅝c. (average price supposed to have been received by United Metals Selling Co. during last decade).

Mar. 22—End of 17-day strike at Nichols Copper Co. refinery at Laurel Hill, Long Island.

Mar. 24—Fire in Utah-Apex mine at Bingham, Utah, beginning on 1000-ft. level, extended to 1300-ft. level, and flooding was resorted to on Mar. 28—Calumet & Arizona's 200-ton sulphuric acid plant started at Douglas, Ariz., providing supply of acid for New Cornelia's copper leaching operations at Ajo.

Mar. 30—Semicentennial of Alaska purchase for $7,200,000.

APRIL

Apr. 1—Milling began at Alaska Juneau Gold Mining Co.—Yuba No. 16 gold dredge, with 18-cu.ft. buckets and double tailings stackers to reclaim Yuba River channel, started digging near Hammonton, Calif.—Wages of employees receiving $3 to $5 per day at the Homestake Mining Co. in South Dakota advanced 16% to 10% respectively—Potash plant, erected near Searles Lake, at Borosolvay, Calif., by Pacific Coast Borax Co. and Solvay Process Co., began operation.

Apr. 2—Ohio Copper Co. of Utah, acquired all stock and majority of bonds of Bingham Central Railway Co., which owns the Mascotte tunnel, the outlet for the Ohio ore.

Apr. 4—Sunnyside and Gold Prince mines in San Juan district, Colorado, optioned to U. S. Smelting, Refining and Mining Exploration Co.

Apr. 5—New mining tax bill passed by Ontario legislature, increasing mainly the tax on nickel and nickel-copper mines.

Apr. 6—United States declared state of war existed with Germany.

Apr. 7—Herbert C. Hoover appointed by United States Council of National Defense to head American Commission on food supply and prices, Mr. Hoover later to become Food Administrator.

Apr. 10—Announcement that Williams-Harvey Corporation, controlled jointly by Williams, Harvey & Co., Ltd., and the National Lead Co., would erect 300-ton, tin-smelting plant on Jamaica Bay, Long Island—Nichols Copper Co. broke ground at its Laurel Hill refinery for a new plant to treat the gold and silver slimes obtained in electrolytic copper refining.

Apr. 16—Chile Copper Co. increased capital from $110,000,000 to $135,000,000 and authorized bond issue of $100,000,000, of which $35,000,000 is to be issued for extensions to plant to triple present capacity—Final decree granted by United States District Court of Montana in suit of Minerals Separation vs. James M. Hyde—Suit of Minerals Separation vs. Butte & Superior for flotation-patent infringement began at Butte, Mont.

Apr. 21—Caving of old workings in Douglas Island mines along the Gastineau Channel caused flooding and closing of Alaska Treadwell, Seven Hundred and Alaska Mexican mines—Ready Bullion mine saved by bulkhead.

Apr. 23—Fire in Anaconda's Modoc mine at Butte resulted in temporary closing of Modoc and High Ore mines, the Speculator and Granite Mountain mines of the North Butte company and the Butte-Ballaklava mine.

Apr. 24—Sale of Big Jim gold mine at Oatman, Ariz., to United Eastern Mining Co. ratified by Big Jim stockholders—Wages advanced 25c. per shift in Tintic district in Utah—Receiver appointed in London for Granville Mining Co., which controls Canadian Klondyke Mining Co., Canadian Power Co. and North West Corporation in Yukon Territory.

Apr. 27—Preliminary leaching begun at New Cornelia Copper Co.'s 5000-ton plant at Cornelia in the Ajo district of Arizona.

Apr. 28—Seven men killed by powder gas on entering unventilated 1400-ft. level of Mountain King gold mine, in Mariposa County, California.

MAY

May 1—Wages in California gold mines increased to maximum of $3.50 and minimum of $3 per shift.

May 6—Cable dispatches announced destructive fire at nickel-refining works of A. S. Kristianssands Nikkelraffineringsverk at Christiansand, Norway.

May 12—Grand Forks, B. C., copper smeltery of Granby Consolidated company forced to curtail operations and finally to cease smelting on account of lack of coke resulting from strike in the Crow's Nest Pass coal region.

May 17—Subcommittee on copper appointed by Bernard M. Baruch, chairman of committee on raw materials of the National Defense Council, membership of copper committee including John D. Ryan, chairman; Murry Guggenheim, Charles M. MacNeill, Rodolphe L. Agassiz, James McLean and W. A. Clark.

May 19—Sales of lead reported at 11c. in New York.

May 23—Announcement that Greene Consolidated Copper Co. would be dissolved and that Greene Cananea would become the sole holding company for the copper operations at Cananea, Son., Mexico.

May 24—Production in Jerome, Ariz., copper mines stopped by miners' strike—Utah Apex mine in Bingham Canyon resumed shipping, after two months shutdown due to fire and flooding of mine.

May 25—Announcement that Bunker Hill & Sullivan Mining and Concentrating Co. would erect a 10-ton electrolytic zinc plant—Case of Minerals Separation, Ltd., vs. Miami Copper Co. in U. S. Circuit Court of Appeals, Philadelphia, for flotation-patent infringement decided in favor of plaintiff.

May 26—Peruvian troops sent to quell strike disorders at Cerro de Pasco copper smeltery at La Fundición; smeltery strike settled May 31—Ontario government passed an Order-in-Council extending for one year assessment work on mining claims.

May 31—"Smoke" damages allowed against smelting companies in Sudbury nickel districts, Ontario, but injunction restraining operation denied, on ground of greatest good to the community.

JUNE

June 4—Miners resume work in Jerome, Ariz., after 10-day strike; union not recognized.

June 7—First electrolytic copper produced by New Cornelia Copper Co.'s leaching plant, Ajo, Ariz.—Announcement of increase in authorized capital stock of American Metal Co. from $3,500,000 to $25,000,000, though immediate actual increase was only to $7,000,000.

June 8—Fire in Granite Mountain mine of North Butte Mining Co., Butte, Mont., resulted in death of 164 men.

June 11—Beginning of I. W. W. strike at Butte, Mont., curtailing work to day shift for the most part with 10 to 25% of the normal crews—American Smelting and Refining Co. resumed operation of two copper furnaces at Aguascalientes, Mexico.

June 12—Price of lead touched 12c. per lb., the highest price reached during 1917—U. S. Steel Corporation and many other mining and metallurgical companies declared special dividends, recommending that stockholders endorse checks in favor of American Red Cross.

June 13—Strike at Tooele, Utah, smeltery of International Smelting Co.; men voted to return to work on June 30.

June 15—Ground broken this month for new reduction works of British America Nickel Corporation at Nickelton, Ontario, to be completed in July, 1919, at cost of $3,000,000.

June 20—Roasting furnaces started at Bunker Hill & Sullivan lead works, Kellogg, Idaho.

June 21—Greene-Cananea copper operations in Sonora, Mexico, closed down as result of interference by government officials, American employees returning to the States.

June 22—Canadian government took over operation of Crow's Nest Pass coal mines, where a strike had been in force for several months resulting in closing of Granby's Grand Forks, B. C., copper smeltery and restriction of other metal production—Exports Council created by President Wilson to assist in regulation of exports, to be composed of the Secretary of State, Secretary of Commerce, Secretary of Agriculture and the Food Administrator.

June 26—I. W. W. union at Bisbee, Ariz., started strike, about 50% of the miners stopping work.

June 27—United States Navy Department placed order for 60,000,000 lb. of copper at 25c. per lb.

JULY

July 1—Strikes at copper mines in various parts of country started by I. W. W. organizations, especially at Clifton, Morenci, Miami and Globe, same organization having already begun strikes at Bisbee and Butte.

July 5—Federal troops sent to Globe, Ariz., to prevent Austrian strikers from interfering with pumpmen and others endeavoring to keep copper mines open—First lead blast furnace of Bunker Hill & Sullivan works blown in.

July 9—Proclamation by the President prohibiting exports of coal, steel, fuel oils, fertilizers, explosives, ferromanganese and other products except by license.

July 12—About 1300 I. W. W.'s and sympathizers, interfering with miners working in Bisbee district, Arizona, were deported by Sheriff Wheeler, assisted by Citizens Protective League—Governor Campbell of Arizona requested President Wilson to send Federal troops to preserve order in Clifton, Morenci, Bisbee, Jerome, Humboldt, Ray, Ajo and in Mohave County—Conference of steel men and Secretary of Navy, Secretary of War and Bernard M. Baruch, chairman of raw-material committee, agreed upon plan for fixing price of steel.

July 13—M. A. Hanna Co., of Cleveland, Ohio, leased large area of Great Northern ore lands.

July 14—Rioting between Americans and foreigners occurred in Flat River and other Southeastern Missouri towns, native miners refusing to permit foreigners to work in lead mines.

July 16—Montana Power Co. and mining companies on one side and Metal Trades Council and electrical workers on other side reached agreement and concluded terms satisfactory to both, but no agreement made with I. W. W. miners' union—Price of silver reached 81¼c. per ounce.

July 18—M. A. Hanna Co., of Cleveland, Ohio, purchased Pennsylvania R.R. Co. coal lands.

July 20—Strike of miners in Leadville district resulted in shutting down of mines.

July 26—Explosion in No. 12 colliery at New Waterford, N. S., belonging to Dominion Coal Co., of Sydney, killed 62 miners.

July 30—Iron miners on Gogebic Range in Michigan struck, following I. W. W. agitation.

July 31—Commandeering of iron mines of Cumberland and Lancaster Counties by British Minister of Munitions announced by U. S. Consul General Skinner, of London.

AUGUST

Aug. 1—Frank Little, I. W. W. agitator, hanged at Butte, Mont., by masked men.

Aug. 2—Leadville, Colo., miners' strike ended.

Aug. 4—Explosion of gas occurred in No. 7 mine of West Kentucky Coal Co., Clay, Ky., killing a total of 61 men, 34 being rescued—Strike at the smeltery of the St. Louis Smelting and Refining Co. at Collinsville, Ill.

Aug. 8—New Jersey Zinc Co. began rolling sheet zinc at Palmerton, Penn.

Aug. 10—U. S. Senate adopted Pittman Bill providing for the leasing of Government lands containing potash and other chemical resources.

Aug. 11—New position of superintendent of experimental stations, with headquarters in Washington, created by Director Van H. Manning of U. S. Bureau of Mines, Dorsey A. Lyon being named as the first incumbent.

Aug. 15—Previous sale of copper to Navy Department at 25c. having been repudiated, it was reported that the War Industries Board had agreed to advance copper producers 22½c., per lb., leaving the difference between that price and 25c. to be settled after receipt of report on cost of production by the Federal Trade Commission—Great Falls refinery reported closed, and Raritan refinery operated at reduced capacity.

Aug. 16—Hereafter shipments of steel to Canada and Newfoundland will not require individual licenses, in order to facilitate exports to those countries.

Aug. 17—New mining experiment stations authorized at Minneapolis for the iron industry and at Columbus, Ohio, for the ceramic industry.

Aug. 19—Arrest by U. S. military authorities of 27 I. W. W. leaders, including James Rowan, district secretary, at Spokane, who issued orders for a general strike of workers in Montana, Idaho, Washington and Oregon, which threatened to retard necessary war materials.

Aug. 21—President Wilson fixes base price of bituminous coal at about $2 per ton of 2000 lb., at mouth of mine—Exports Administrative Board established by the President, superseding order of June 22 establishing an Exports Council, to be composed of the council with addition of the Chairman of the Shipping Board.

Aug. 24—Dr. H. A. Garfield, president of Williams College named as Fuel Administrator—Price of anthracite (except for buckwheat) fixed at $4 to $5.30, according to locality and size.

Aug. 27—Closing of smelteries in Anaconda and Great Falls by labor strikes resulted in shutdown of Anaconda mines at Butte—Second proclamation of the President prohibiting exports of war materials to Central Powers and other countries.

Aug. 30—Price of silver in New York reached 90¾c., the highest in 25 years.

SEPTEMBER

Sept. 1—Spelter production estimated at about 55,000 tons per month, or 10,000 tons less than the maximum.

Sept. 5—Minerals Separation won its suit in U. S. District Court in Montana for infringement of flotation patents by Butte & Superior, which continued to operate under special agreement. —I. W. W. headquarters throughout the United States were raided on orders from Attorney General Gregory.

Sept. 8—Decree granted by U. S. District Court of Delaware in favor of Minerals Separation. in the flotation suit against the Miami Copper Co., which continued to operate under bond—Mexican House of Congress passed bill providing for the temporary taking over and management by the government of idle industries.

Sept. 10—Embargo on exportation of gold proclaimed by President Wilson.

Sept. 12—Among the Eastern copper refineries, one still closed, two others operating at greatly reduced capacity, and a third reported about at the end of its stock of blister copper.

Sept. 13—Shasta County, Calif., copper miners and smeltermen returned to work.

Sept. 17—Anaconda reported about half the normal force at work in its mines—Exports Administration Board issued "Conservation List" giving partial list of materials the export of which is prohibited.

Sept. 19—Further list of materials issued, the export of which is prohibited except under license.

Sept. 20—American Federation of Labor requests President Wilson to appoint committee to investigate Arizona labor conditions—Price of silver advanced to $1.08½ per ounce, the highest figure reached in 1917 and for over 25 years.

Sept. 21—Copper price of 23½c. per lb., f.o.b. New York, to the Government, Allies and the public was fixed by voluntary agreement between the Government and leading copper producers, effective for four months, producers agreeing not to reduce wages and to maintain maximum output.

Sept. 24—War Industries Board and steel producers agree to reduction in price of pig iron, some steel products and coke, effective for four months, $33 for pig iron and $6 for coke.

Sept. 28—Copper producers organized a new Copper Producers Committee to conduct the copper business of the country under the new conditions.

OCTOBER

Oct. 1—President Wilson signed the Potash Lands Leasing Bill.

Oct. 2—The principal copper consumers formed a committee to confer with the Copper Producers Committee.

Oct. 4—Plant of Empire Smelting and Refining Co., Deming, N. M., destroyed by fire.

Oct. 5—Bill passed by Congress providing for suspension of annual assessment work on mining claims during 1917 and 1918.

Oct. 6—Federal Reserve Board arranged to supply necessary amount of gold to permit American companies operating in Mexico to continue—"Trading with the Enemy Act" approved.

Oct. 12—War Trade Board established by order of the President to regulate exports of certain products.

Oct. 16—President Wilson approves site of nitrate plant at Muscle Shoals, near Sheffield, Alabama.

Oct. 17—The metals division of the National Association of Waste Materials Dealers agreed to work in harmony with the War Industries Board on the basis of 23½c. per lb. for copper—The Federal Lead Co. curtailed production at its mines in Missouri to one-half.

Oct. 20—Rockefeller plan of adjustment of industrial labor disputes upheld by Colorado State Industrial Commission.

Oct. 22—Additions to "Conservation List" of materials requiring export licenses.

Oct. 23—Globe-Miami strike settled through efforts of labor commission appointed by President Wilson.

Oct. 24—Headquarters of Metal Mine Workers (I. W. W. union) at Anaconda, Mont., raided and strike leaders arrested on the charge of interfering with copper production.

Oct. 25—Potash plant of Mineral Products Corporation at Alunite, six miles west of Marysvale, Utah, destroyed by fire.

Oct. 29—Advance of 45c. per ton on bituminous coal allowed by Fuel Administrator.

Oct. 30—Labor commission arranges settlement of strike in Clifton-Morenci-Metcalf copper district, in Arizona—Labor strike reported in Texas and Louisiana oil fields; about 9000 men out. —I. W. W. activity in Tulsa, Okla., oil fields reported.

NOVEMBER

Nov. 3—Announced that a special mining regiment known as the 27th Engineers would be raised by voluntary enlistment.

Nov. 4—Yuba No. 17 gold dredge launched near Hammonton, California.

Nov. 5—I. W. W. headquarters raided in Tulsa, Okla., oil fields and nine members arrested, subsequent to the dynamiting of the home of J. Edgar Pew, general manager of Carter Oil Co.—Maximum prices approved by the President for cold-rolled steel, wire, tin plate, pipe, sheets and scrap, as agreed upon by War Industries Board and steel producers—Embargo at two Murray sampling mill of Utah Ore Sampling Co. lifted.

Nov. 6—National Fuel Administrator H. A. Garfield issued order requisitioning 10% of output of every U. S. coal mine.

Nov. 8—Seventeen I. W. W. members flogged, tarred and feathered in Tulsa, Okla., by a band of masked men.

Nov. 12—Osage Indian oil leases, covering area of 20,000 acres, sold.

Nov. 13—Zinc producers organized a committee to coöperate with the War Industries Board in fixing a basis for establishing prices for the several grades of spelter.

Nov. 15—Law regulating manufacture, sale, storage and use of explosives became effective, F. S. Peabody being appointed to take charge of its enforcement.

Nov. 17—Oliver Iron Mining Co. announced that part of town of Hibbing, Minn., will be removed to facilitate mining of underlying orebody.

Nov. 18—Mexican government during this week issued circular prohibiting any new denouncements of mining claims.

Nov. 20—In Butler County oil fields of Kansas, 50 I. W. W. workers were arrested in connection with labor troubles.

Nov. 24—Comfort Club organized in connection with mining regiment, the 27th Engineers.

Nov. 25—Mexican decree issued establishing damage claim bureaus to adjust claims arising from the revolution.

Nov. 26—U. S. Government attaches all tin assaying over 99.75% stored in warehouses—Mill of Dome Mines, Ltd., in Porcupine, Ont., ordered shut down by directors, owing to inability to make profit under current conditions.

Nov. 29—Suit involving ownership of tailings dumped on adjoining property decided by Canadian court in favor of Peterson Lake Mining Co. against the Dominion Reduction Co.

Nov. 30—Price of tin at New York jumped to 88c. per lb., the highest figure during 1917.

DECEMBER

Dec. 1—Decree issued by Mexican government providing for taxation of metal exports—Advance of 35c. per ton allowed on anthracite by Fuel Administrator—Chiksan Mining Co.'s dredge went into operation in Chosen.

Dec. 6—Department of Interior ready to issue permits for prospecting for potash on public lands—Yukon gold dredge started operating on Prichard Creek, Idaho—International Nickel Co.'s new electrolytic refinery, Port Colburne, Ontario, practically completed.

Dec. 7—United States declares state of war exists with Austria.

Dec. 10—Greene Cananea resumed operation, after shutdown of mines June 22—Hereafter, tin imports will be regulated by American Iron and Steel Institute.

Dec. 11—Ore shipments from Duluth, Minn., docks closed at head of the Lakes.

Dec. 15—Mexican gold embargo will be raised as result of agreement between United States and Mexico, the former being obliged to return the entire gold content of the ore and 25% of the silver extracted—Navigation between Lake Superior and lower lakes closed—D. C. Jackling appointed by Secretary Baker to take charge of construction work of Government explosives plants involving expenditure of $90,000,000.

Dec. 18—I. W. W. union at Butte formally voted to call off strike—Production of Anaconda Copper Mining Co. for last several weeks was up to 90% of normal.

Dec. 21—End of strike, which started Nov. 15, at smeltery of Consolidated Mining and Smelting Co., at Trail, B. C.

Dec. 25—Electrolytic Zinc Co. of Australia started its 10-ton electrolytic zinc plant near Hobart, Tasmania.

Dec. 28—Government operation of railroads of United States begun at noon, under the direction of William G. McAdoo, Secretary of the Treasury—Maximum prices on iron ore, coke, pig iron, steel and steel products directed by the President to be continued in effect until Mar. 31, 1918, the same having been subject to revision Jan. 1, 1918.

New Mining and Metallurgical Construction in 1917

Alabama Graphite compan[y] which completed construction work were as follows: The Ac[me] at Ashland, completed 200-ton plant and started operations [Dec.] 1, 1917; the Alabama at Ashland, No. 2 plant, of 40-ton capacity daily and No. 3 of 400 tons daily; Allen, Ashland, 100-to[n] plant started Sept. 15; American, Ashland, 150-ton, July 1; Atlas, Ashland, 100-ton, Oct. 1; Axton-Noe, Ashland, 150-ton, July; Ceylon, Goodwater, 125-ton, February; Crucible Flake, Ashland, 100-ton, October; Enterprise, Lineville, 100-ton, about Nov. 1; Eagle, Ashland, 150-ton, June 15; Goodwater, Goodwater, 150-ton, July; Griesmer, Ashland, 400-ton, Aug. 2; Great Southern, Lineville, 100-ton, Oct. 15; Gulf States, Ashland, 100-ton, Nov. 1; Hood-Graves, Ashland, 100-ton, Oct. 1; Jennings No. 2, Ashland, 100-ton, July; King, Ashland, 100-ton, October; Lineville, Lineville, 100-ton, May; Monitor, Ashland, 100-ton, Sept. 1; May Bros., Ashland, 400-ton, Oct. 1; National, Ashland, 100-ton, Aug. 2; Peerless, Lineville, 100-ton, July; Republic, Ashland, 100-ton, October; Southern Star, Ashland, 100-ton, October. Companies, which did construction work but did not complete plants were as follows: Birmingham, Pyriton, 100-ton plant; Carbon Mt., Lineville, 100 tons; Empire, Ashland, 100 tons; Graphite Co. of America, Goodwater, 300 tons; Norway Graphite Milling Co., Chandler Spring, 100-ton; Orleans Flake, Lineville, 100-ton; Superior Flake, Ashland, 100-ton plant.

Birmingham-Trussville Iron Co., Trussville, Jefferson County, Ala., completed construction of furnace of 250-ton daily capacity, installation of skip hoist, four Cahall boilers and new stock house at cost of $500,000; plant ready for operation about Jan. 1, 1918.

Central Coal and Iron Co., Holt, Tuscaloosa County, Ala., remodelling tipple, relaying tracks and installing new boilers at Valley View mine at estimated cost of $50,000.

Gulf States Steel Co., Shannon, Jefferson County, Ala., started construction of mining plant with capacity of 1000 tons iron ore daily at estimated cost of $250,000; to be completed in spring of 1918.

Republic Iron and Steel Co., Thomas (Sta. Birmingham), Jefferson County, Ala., completed installation of two Curtis-General Electric, 2500-kw. generators.

Sloss Sheffield Steel and Iron Co., Birmingham, Jefferson County, Ala., completed new tipple at Sloss No. 1 Red Ore Mine in December, 1917.

Southern Manganese Corporation, Anniston, Calhoun County, Ala., completed construction of 10 electric furnaces for producing ferromanganese, adding two more furnaces making total capacity of about 100 tons daily, to be in operation about Jan. 1, 1918; estimated cost is $500,000.

Sheffield Steel Corporation, Sheffield, Colbert County, Ala., repairing two 250-ton furnaces to be in operation Apr. 1, 1918; also equipping brown-ore mines at Russellville, coke ovens at Jasper; cost estimated at $1,000,000.

Shelby Iron Co., Shelby, Shelby County, Ala., remodeling second furnace to have 300-ton total daily capacity.

Talladega Iron Co., Talladega, Talladega County, Ala., remodeled 250-ton furnace to be in operation Feb. 1, 1918.

Woodward Iron Co., Woodward, Jefferson County, Ala., started construction of railroad preparatory to sinking vertical shaft in Sec. 24, T. 24, R. 4.

Alaska Juneau, Juneau, Alaska, started one unit of new mill in operation at end of March and additional units later in year. Planned to increase 12 ball-mill units to 1000-ton daily capacity, making total ultimate capacity, 11,000 tons daily.

Admiralty-Alaska Gold Mining Co., Funter, Alaska, started construction 2000-ft. power pipe line; installed 12-drill compressor and expect 10-drill compressor to be in operation soon.

Kennecott Copper Corp., Kennecott, Alaska, enlarging 300-ton ammonia-leaching plant for tailings, to 800 tons daily capacity; extensions to be completed April, 1918. Mill at Beatson plant on Latouche Island being increased to 1500-ton daily capacity; extensions to be completed January, 1918.

Mother Lode Copper Mines Co., McCarthy, Alaska, removed Kennecott's small mill 16 miles to millsite; completed 500-kw. power plant; installed compressor chamber underground; additional buildings and tramway being installed.

Calumet & Arizona Mining Co., Douglas, Cochise County, Ariz., completed construction of sulphuric acid plant of 200-ton daily capacity at cost of $1,000,000 in April, 1917.

Mineral Development Co., Mineral Park, Chloride district, Cochise County, Ariz., known as Golden Hammer, completed installation of new equipment including compressor, engine, hoist, 600-ft. tunnel and 90-ft. shaft. Also developed process for treatment of ore carrying gold, silver, lead, copper and zinc.

Shattuck Arizona Copper Co., Bisbee, Cochise County, Ariz., started construction of lead concentrator of 400-ton daily capacity at estimated cost of $225,000.

Arizona Middlemarch Copper Co., Pearce, Gila County, Ariz., built flotation mill of 100-ton daily capacity.

Young Mines Co., Ltd., Phoenix, Maricopa County, Ariz., started construction of third unit of 250-ton amalgamating and cyanide plant at estimated cost of $20,000, to be completed in March, 1918.

Arizona Ore Reduction Co., Chloride, Mohave County, Ariz., constructing 250-ton concentrating and roasting plant at Copper Age property at estimated cost of $125,000, to be completed in January, 1918.

McCracken Silver-Lead Mines Co., Yucca, Mohave County, Ariz., started construction of Stebbins dry concentrating mill of 100-ton daily capacity at site known as McCracken, Ariz.; to be completed Jan. 15, 1918, at estimated cost of $20,000.

Tom Reed Gold Mines Co., Oatman, Mohave County, Ariz., completed extension of continuous decantation cyanide plant to 300-ton daily capacity at cost of $80,000.

United Eastern Mining Co., Oatman, Mohave County, Ariz., enlarged mill by addition of three agitators and two thickeners.

New Cornelia Copper Co., Ajo, Pima County, Ariz., completed 5000-ton leaching plant in July.

Copper State Mining Co., Copper Creek, Pinal County, Ariz., remodeled old mill to 150 to 180 tons daily capacity.

Ray Hercules Copper Co., Ray, Pinal County, Ariz., started construction at Kelvin of concentrating plant of 1500-ton daily capacity.

United States Vanadium Development Co., Kelvin, Pinal County, Ariz., started construction of "Bryan" dry classifier and concentrator of 50-ton daily capacity; estimated cost of $45,000; to be completed on Jan. 10, 1918; leaching plant may be added later to extract vanadium remaining in 200-mesh material by wet process.

Wandering Jew Co., Alto, Santa Cruz County, Ariz., completed installation of plant including crusher, rolls and tables of 70-ton daily capacity at cost of about $5000.

Bradshaw Reduction Co., Crown King, Yavapai County, Ariz., completed construction of 100-ton mill; cost $40,000; at present reconstructing old Tiger mill to treat tailings and possibly dumps.

General Mines Co. of Nevada, Prescott, Yavapai County, Ariz., completed 50-ton mining plant at cost of $10,000 on Oct. 1, 1917.

Great Western Smelters Corporation, Mayer, Yavapai County, Ariz., started construction of blast-furnace and converter plant.

United Verde Extension Mining Co., Jerome, Yavapai County, Ariz., started construction of smelting plant of 500-ton daily capacity at estimated cost of $3,000,000; 20,000 cu.yd. concrete already laid; driving long transportation and development tunnel.

Carmelita Mining and Milling Co., Wenden, Yuma County, Ariz., started installation of 50-ton mill at estimated cost of $25,000; to be completed Feb. 20, 1918.

King Placer Consolidated, Quartzsite, Yuma County, Ariz., started construction of dry-placer plant, of 2000-cu.yd. daily capacity.

Liberty Lead and Zinc Co., Yellville, Marion County, Ark., completed 150-ton mill at cost of $40,000.

North Star Mining Co., Yellville, Marion County, Ark., completed construction of 50-ton zinc mill; cost $20,000.

Standard Zinc Co., Helva, Marion County, Ark., started construction of $30,000 mining plant.

Electric Mining Co., Tomahawk, Searcy County, Ark., recently taken over by new interests, started 50-ton zinc plant; estimated cost $5000.

California Slimes Concentrating Co., Argonaut mine, Jackson, Amador County, Calif., constructing 300-ton tube-milling, amalgamating and concentrating plant; estimated cost $25,000.

Old Eureka Mining Co., Sutter Creek, Amador County, Calif., completed construction of hoisting equipment including installation of Wellman-Seaver-Morgan double electric hoist of 16,000-lb. capacity with 800-ft. rope speed; cost, $75,000.

California National Gold Mining Co., Oroville, Butte County, Calif., completed 500-ton mining plant at Bloomer, at cost of $130,000.

Cerise Gold Mining Co., Wilbur Springs, Colusa County, Calif., started construction of mill.

Calaveras Consolidated, Melones, Calaveras County, Calif., installed 10-stamp mill.

Pacific Electro Metals Co., Baypoint, Contra Costa County, Calif., completed ferroalloy plant; estimated cost, $400,000.

Beebe, Georgetown, Eldorado County, Calif., installed Pelton wheel, Ingersoll-Rand compressor, air hoist, five-stamp mill.

Montezuma, Nashville, Eldorado County, Calif., mill under construction.

Placer Chrome Co., New Castle, Eldorado County, Calif., constructed 15-ton concentrating plant; cost, $15,000.

California Alkali, Olanche, Inyo County, Calif., installed plant for recovery of chemical products from the waters of Owens Lake; plant situated at Cartago.

Darwin Development, Darwin, Inyo County, Calif., completed new vertical shaft on Lucky Jim, constructed bunk house, library and other surface buildings; pending further action on proposed railroad between Darwin and Olanche, the motor-truck road connecting with Olanche is under reconstruction.

Round Valley Tungsten Co., Bishop, Inyo County, Calif., completed 125-ton mill; cost $25,000.

Standard Tungsten, Bishop, Inyo County, Calif., enlarged mill.

Tungsten Mines Co., Bishop, Inyo County, Calif., reconstructed portion of mill burned Apr. 27; since then mill has been entirely remodeled with different flow sheet.

Gambetta, Grub Gulch, Madera County, Calif., installed Byron Jackson sinking pump, amalgamation and concentration plant, including two Overstrom tables, conveyor elevator and bins.

Number Nine, Hornitos, Mariposa County, Calif., installed hoist and surface buildings.

Ruth Pierce, Hornitos, Mariposa County, Calif., installed hoist and constructed surface buildings.

Nevada Progressive, Silverado, Mono County, Calif., installed 60-ton cyanide plant.

Allison Ranch, Grass Valley, Nevada County, Calif., completed hoisting and pumping plant, 20-stamp mill, 100-ton cyanide plant, installed Oliver filter at cost of $200,000.

Champion, Grass Valley, Nevada County, Calif., put in new concrete floors and rebuilt cyanide plant.

Delhi, North Columbia, Nevada County, Calif., removed equipment, including saw mill, from copper works to stamp-mill site.

Empire, Grass Valley, Nevada County, Calif., installed additional compressor plant.

Golden Center, Grass Valley, Nevada County, Calif., installed five-stamp mill and concentrating table.

Grass Valley Consolidated Gold Mines, Allison Ranch Mine, Grass Valley, Nevada County, Calif., completed headframe, hoist, shops, dryhouse, mill and cyanide plant, of 120 tons daily capacity, at cost of $135,000; in operation April, 1917.

North Star, Grass Valley, Nevada County, Calif., remodeled stamp mill and cyanide plant.

Major Gold Mining Co., Nevada City, Nevada County, Calif., completed 20-ton stamp mill; cost, $4000.

Valley View, Lincoln, Placer County, Calif., installed headframe and Hendy ball mill on this copper property.

Engels Copper, Engelmine, Plumas County, Calif., increased flotation equipment from 500 tons capacity by one 750-ton unit, additional units to be added to a total maximum capacity of 3000 tons; this new installation includes two gyratory crushers, two ball mills, two ball pebble mills, Dorr classifiers, two Ingersoll-Rand compressors; estimated cost of $300,000; to be completed in January, 1918; also completed construction of Indian Valley R.R., 22 miles, connecting mines with Western Pacific Ry. at Keddie.

Philadelphia Exploration, Crescent Mills, Plumas County, Calif., installed pumping plant, hoist and constructed surface buildings.

Natomas Company, Natoma, Sacramento County, Calif., started reconstruction of No. 2 dredge from single stacker to four stackers for reclamation of land coincident with recovery of gold.

Atolia Tungsten, Atolia, San Bernardino County, Calif., installed new concentrating mill for treatment of tailings for recovery of tungstic acid.

Mohave Annex Tungsten Co., Barnwell, Calif., completed construction of 25-ton reduction plant, 1½ miles south of Brant station; cost, $10,000.

Afterthought, Ingot, Shasta County, Calif., installed 300-ton concentrating and flotation plant at this copper-zinc property; completed in September, 1917.

Mammoth Copper, Kennett, Shasta County, Calif., completed installation of new electrolytic zinc plant at cost of $350,000; capacity 9000 tons annually.

Irelan, Alleghany, Sierra County, Calif., installed five-stamp mill, Hendy ball mill and two concentrators.

Mariposa, Alleghany, Sierra County, Calif., installed five-stamp mill and 10 x 14-in. Ingersoll-Rand compressor.

Morning Glory, Alleghany, Sierra County, Calif., installed five-stamp mill, two compressors and Johnson concentrator.

Mugwump, Forest, Sierra County, Calif., installed two 25-hp. motors, 75-cu.ft. blower, ball mill, 50-hp. electric hoist and transformer house.

Pacific Gold Dredging, Carrville, Trinity County, Calif., removed and reconstructed 9½-cu.ft. bucket dredge.

Eagle-Shawmut, Shawmut, Tuolumne County, Calif., controlled by Tonopah-Belmont Development Co. started construction of flotation plant with stamps and tube mills, of 400-ton daily capacity, to be completed about March, 1918.

Yuba Consolidated, Hammonton, Yuba County, completed installation of Yuba No. 16 dredge, 18-cu.ft. bucket capacity, equipped with two tailings stackers for reclaiming Yuba River channel; first steel laid Oct. 13, 1916, launched Nov. 26, 1916, in commission Apr. 1, 1917; also laid first steel Yuba No. 17 dredge, 18-cu.ft. bucket capacity, single stacker, Aug. 4, 1917, launched Nov. 4, 1917, to be completed in March, 1918.

Consolidated Leasing Co., Eldorado, Boulder County, Colo., building 20-ton concentration plant using flotation; cost $10,000.

Nil Desperandum Mines Co., Sunshine, Boulder County, Colo., installed compressors, electric power plant, 1000-ft. electric hoist.

Utica Mining and Milling Co., Ward, Boulder County, Colo., installed pumping plant for unwatering Utica and Stoughton mines; operation to be completed about Jan. 10, 1918.

Paramount Reduction Co., St. Elmo, Chaffee County, Colo., completed 75-ton concentrator including flotation equipment for complex sulphide ores.

Argo Leasing Co., in Daily District, 12 miles west of Empire, Clear Creek County, Colo., completed 50-ton concentrator including crusher, ball mill and three Wilfley tables; estimated cost, $10,000.

Argo Reduction and Ore Purchasing Co., Jackson Mill, Idaho Springs, Clear Creek County, Colo., remodeled mill installing flotation and regrinding equipment of 100-ton daily capacity, at cost of $15,000. Now in operation as custom mill.

Colorado Central Mining Co., Georgetown, Clear Creek County, Colo., started construction of concentrating plant of 150-ton daily capacity, main plant of 750-ton daily capacity and rock house, at estimated cost of $80,000 to be completed in April, 1918.

Genesee Mine, Ironton, Ouray County, Colo., completed construction of flotation mill.

Mountain Top Mining Co., Ouray, Ouray County, Colo., started construction of 2300-ft. aerial tramway; underground mill completed and in operation.

Vernon Mining Co., Gladstone, Ouray County, Colo., built 60-ton mill; being enlarged to 100 tons.

Yellow Jacket Mines Co., Ouray, Ouray County, Colo., started construction of 50-ton mill for zinc-lead ore.

Commonwealth Mining Co., Alma, Park County, Colo., completed installation of 40-ton cyanide equipment in mill and erection of tramway; cost, $25,000.

London Mine, Alma, Park County, Colo., completed installation of new steam-driven compressor plant at portal of new lower adit now being driven.

Hamlet Mining and Milling Co., Silverton, San Juan County, Colo., completed alterations and repairing of 150-ton concentration mill.

Sunnyside Mining and Milling Co., Eureka, San Juan County, Colo., started construction of flotation mill of 500-ton daily capacity. Mill now operating; tramway, mining plant and power line to be completed by Mar. 1, 1918.

Alta, Telluride, San Miguel County, Colo., purchased from Wagner Development Co. by Tonopah Belmont Development Co.; enlarging mill to capacity of 500 tons daily; new boarding and lunch houses being built.

Lewis Mining and Leasing Co., Telluride, San Miguel County, Colo., constructed 50-ton mill and tramway; repaired plant; installed flotation equipment and unwatered mine.

Evans Dredge, Breckenridge, Summit County, Colo.; construction was started by Yuba Manufacturing Co. of California; capacity 4000 cu.yd. daily.

Independence Mill of Portland Gold Mining Co. at Victor, Teller County, Colo., being enlarged by sixth unit; estimated capacity of new unit is 250 tons daily.

Reid Mill, Cripple Creek, Teller County, Colo., alterations and electrification completed.

American Smelting and Refining Co., Denver, Colo., at Arkansas Valley plant installed mechanical ore-handling system consisting of electric-driven lorries for distribution and bedding-down of charges; two new Dwight-Lloyd sintering machines added to roasting installation; large baghouse completed; Cottrell plant under construction.

Copper Basin Mining Co., Copper Basin, via Mackay, Custer County, Idaho, constructed boiler, compressor plant and sawmill. Plans for reduction works discontinued for duration of the war.

Empire Copper Co., Mackay, Custer County, Idaho, competed installation of compressor plant at Cossack tunnel in October, 1917; 36 towers for 16,300-ft. aërial tramway of 50-ton capacity erected; upper ore bin and head house being constructed; framing timbers for other surface structures.

Bunker Hill & Sullivan, Kellogg, Shoshone County, Idaho, completed silver-lead smelting works; three blast furnaces of 200-ton daily capacity each; also refinery.

Consolidated Interstate-Callahan Mining Co., Wallace, Shoshone County, Idaho, completed additional flotation unit to mill, increasing daily capacity about 300 tons.

Constitution Mining and Milling Co., Masonia, Idaho, Shoshone County, completed 100-ton mill on Pine Creek.

Federal Mining and Smelting Co., Wallace, Shoshone County, Idaho, completed large addition to flotation plant at Morning Mine, Mullan; also completed change house at cost of $20,000.

Giant Ledge Mining Co., Murray, Shoshone County, Idaho, started construction of mill to have initial daily capacity of 100 tons, estimated cost of $35,000.

Hayes Mining Co., Kellogg, Shoshone County, Idaho, completed construction of mill of 100-ton daily capacity to treat accumulation of tailings held by dam in river.

Hecla Mining Co., Burke, Shoshone County, Idaho, completed addition to mill at Gem, increasing capacity from 300 to 500 tons per day.

Northern Light Mining and Milling Co., Kellogg, Shoshone County, Idaho, started construction of concentrating mill; now postponed awaiting completion of Pine Creek railway.

Ray-Jefferson Mining Co., Wallace, Shoshone County, Idaho, completed on Beaver creek 400-ton lead-zinc mill using flotation.

Tamarack & Custer Consolidated Mining Co., Wallace, Shoshone County, Idaho, remodeled plant and added new machinery, increasing capacity to 400 tons per day at old Frisco mill near Gem, which was acquired by company.

Yukon Gold Co., Murray, Shoshone County, Idaho, completed installation of 9-cu.ft. dredge on Prichard Creek.

Allouez Mining Co., Allouez, Mich., installed new boilers throughout and entire surface plant improved.

Calumet & Hecla, Calumet, Mich., completed 2000-ton ammonia-leaching plant in February at Lake Linden and started construction of addition to double capacity, having let contract to American Bridge Co.; foundations for substation for power transmission and steel addition to coal docks completed; constructing 3000 x 20-ft. drainage canal in Swedetown swamp to eliminate excessive pumping in mine workings.

Lake Milling, Smelting and Refining Co., Point Mills, Mich., started installation of two additional stamp heads to the six already in operation; to be completed about June, 1918.

Quincy Mining Co., Hancock, Mich., completed installation of new hoist capable of hoisting from inclined depth of 10,000 ft.

Seneca Copper, Hancock, Mich., constructed piers for shaft house; will install boiler and hoist already purchased; moved shaft-sinking equipment to site and started construction of spur of Keweenaw Central Railroad.

Wauseca, Iron Mountain, Mich., operated by Mineral Mining Co., Iron River, Mich., completed new concrete-lined shaft for distance of 500 ft. at property at Iron River.

Cleveland Cliffs, Ishpeming, iron district, Mich., started construction of dam for new hydro-electric plant to develop 10,000 hp., to be built on Dead River; also erecting new hospital for miners.

Cuyuna-Mille Lacs Iron Co., Ironton, Cuyuna range, Minn., started construction of new hoisting shaft, boiler and engine house, dry house, steel headframe, two electric hoists, cage and three one-ton skips, with 1000-ton daily capacity; estimated cost $75,000; to be completed in February, 1918.

E. J. Longyear Co., Hibbing, Minn., started building of brick sample warehouse replacing one sold to state for chemical laboratory.

Great Northern Power Co., Duluth, Minn., completed extensive improvements to steam plant at Virginia, Mesabi range; built 90-mile transmission line from hydro-electric plant at Thompson Dam, near Duluth; electric power now furnished to following mines: Utica, Albany, Mahoning, North Uno, Leonard, Frantz, Hobart, and others.

Mace Iron Mining Co., Hibbing, Mesabi range, Minn., built gravity screening plant for separation of coarse rock and ore at Keewatin.

Oliver Iron Mining Co., Hibbing, Mesabi range, Minn., completed erection of steam plant at [illegible] Carson Lake mine.

Patrick Mine, Keewatin, Mesabi range, Minn., Butler Bros. completed construction of washing plant.

Pickands Mather Co., Hibbing, Mesabi range, Minn., changed plant from steam to electricity at Albany and Utica mines; at Majorca mine, Calumet, started construction of concentrating plant with about 1000-tons daily capacity at estimated cost of $100,000 to be completed June 1, 1918.

Shada Mining Co., Nashwauk, Mesabi range, Minn., at Pearson mine completed construction of washing plant.

York Iron Mining Co., Nashwauk, Mesabi range, Minn., completed construction of washing plant at York mine.

American Metal Co., Joplin, Mo., started construction of mill on ground acquired from Hayden-Jackling-McKelvie syndicate.

Ben B. Mining Co., West Seventh St., Joplin, Mo., completed construction of 115-ton mill; estimated cost, $40,000.

Georgette Mining Co., Wentworth, Mo., completed construction of 200-ton mill; cost, $25,000.

Metropolitan Zinc Co., Wentworth, Newton County, Mo., constructed 300-ton mill; cost, $35,000

O. & M. Mining Co., Webb City, Mo., completed 500-ton mill; cost $120,000, including installation of Fishkill engine and Nordberg compressor; started operating Sept. 10, 1917.

Oronogo Circle Mining Co., Oronogo, Mo., operated by Connecticut Zinc Corporation, completed construction of 1800-ton mill, using nine jigs, five Dorr thickeners, 800-ft. belt conveyor and sludge department of 32 tables; also will install steam shovel for use on tract of Granby land.

Oronogo Mutual Mines, Oronogo, Mo., completed 1000-ton mill; cost, $90,000.

Scott Mining Co., Duenweg, Joplin District, Mo., started construction of 300-ton mill at estimated cost of $35,000, to be completed Feb. 15, 1918.

Admiralty Zinc Co., Douthat, Okla., constructed concentrator of 600-ton capacity; estimated cost of $85,00

Golden Eagle Mining Co., St. Louis, Okla., completed 400-ton mill; cost, $75,000.

Laclede Lead and Zinc Co., Tar River, Okla., completed 600-ton mill; cost, $65,000.

Muskogee Lead and Zinc Mining Co. (Box 191), Quapaw, Okla., started construction 250-ton mill; estimated cost, $75,000.

Niagua Mining and Royalty Co., near Picher, Okla., completed 650-ton mill; cost, $70,000.

O. M. Bilharz Mining Co., Baxter Springs, Kan., started construction 600-ton mill on former site of Blue Bird mill, in Ottawa County, Okla.; cost, including development of mines, $75,000; to be completed Mar. 1, 1918. Also building new compressor plant, centrally situated between company's three properties.

Ontario Smelting Co., near Quapaw, Okla., started construction of 100-ton lead smeltery; cost, $200,000.

Rainbow Lead and Zinc Co., Quapaw, Okla., started construction of 300-ton mill.

Rialto Mining Co., Tar River, Okla., completed construction of 700-ton mill; cost, $156,000.

Standard Zinc, Lead, Mining Co., Picher, Okla., completed 250-ton concentrator and mining plant at cost of $150,000, on Dec. 15, 1917.

William Foster White Lease, Picher, Okla., completed construction of zinc-mining and milling plant of 840-ton daily capacity; cost, $150,000.

Velie Mines Corporation, Tar River, Okla., general offices, Frisco Bldg., Joplin, Mo., constructed two mills; 1200 tons' capacity; cost, $275,000.

Boston & Montana Development, Wise River, Beaverhead County, Mont., constructing 37-mile narrow-gage railroad from Divide to mines in Elkhorn District; also constructing 500-ton mill.

Hidden Lake Mine, Cable District, Derrlodge County, Mont., operated by National Tungsten and Silver Co., started construction of 150-ton cyanide plant.

Philipsburg Mining Co., Philipsburg, Granite County, Mont., started construction of 300-ton washing and concentrating plant at estimated cost of $35,000, to be completed in December, 1917.

Richmond Mining, Milling and Reduction Co., Saltese, Mineral County, Mont., completed tramway, two miles long, of 225-ton daily capacity at cost of $22,500, in April, 1917; installing 12 x 12-in. compressor, 80-hp. gasoline engine and No. 6 Cameron sinking pump.

Vermilion Silver and Lead Co., Trout Creek, Sanders County, Mont., completing 40-ton mill using flotation with cyanidation on galena ore carrying gold and silver.

Anaconda Copper Mining Co., Butte, Silver Bow County, Mont., completed Cottrell installation; added 50-ton unit to sulphuric-acid plant; fireproofing of Tramway shaft for distance of 2475 ft. at

$21.50 per ft. completed; new steel gallows frame and ore bins at Alice mine, Butte, completed; constructing flume and pipe lines for hydraulic-filling system to extinguish mine fires; started construction of large dams, over mile in length, with ultimate height of 60 ft. for settling fine tailings from flotation plants; completed foundations for wire mill at Cascade.

Davis-Daly Copper Co., Butte, Silver Bow County, Mont., erected new headframe at Hibernia mine.

North Butte Mining Co., Butte, Silver Bow County, Mont., concreting Granite Mountain shaft; started construction of surface plant at Sarsfield claim.

Elm Orlu Mining Co., Butte, Silver Bow County, Mont., completed installation of new electric hoist.

Holden Mining and Milling Co., Tuscarora, Elko County, Nev., constructing 150-ton mill at estimated cost of $50,000.

Red Hill Florence Mining Co., Goldfield, Esmeralda County, Nev., retimbered double-compartment shaft to 550-ft. point and sinking 250 ft. additional.

Gold Top Mining Co., Battle Mountain, Lander County, Nev., installed 35-ton ball mill now in operation.

White Caps, Manhattan, Nye County, Nev., completed 150-ton crushing and cyaniding plant; also 22½-ft. diameter, seven-hearth, Wedge mechanical roasting furnace.

White Caps Extension, Manhattan, Nye County, Nev., completed surface plant and bunk house for 16 men.

Consolidated Coppermines, Kimberly, White Pine County, Nev., completed second unit of flotation mill; Dorr thickener plant.

Nevada Consolidated Copper Co., McGill, White Pine County, Nev., installed new coal-crushing and storage plant at cost of $400,000.

United Nevada, Ely, White Pine County, Nev., started construction of three-mile tramway of 200-ton daily capacity.

85 Mine, Lordsburg, Grant County, N. M., started erection of 350- to 400-ton mill using flotation; dam being built near power house to collect mine water; grading for spur from Arizona & New Mexico Railroad.

Senorito Copper Co., Senorito, Sandoval County, N. M., contracted for Greenawalt leaching and electrolytic plant, but owing to delayed delivery, erected 100-ton semi-fusion reduction plant for carbonate ore; began construction 60-ton reverberatory.

Santa Fe Dredging Co., Golden, Santa Fe County, N. M., started construction of gold dredge of 3000-cu.yd. daily capacity, at estimated cost of $250,000, contract given to Yuba Manufacturing Co. of San Francisco; date of completion, Mar. 1, 1918.

Williams, Harvey Corporation, 115 Broadway, New York, began erection of tin-smelting plant on Jamaica Bay, Long Island; three reverberatory smelting furnaces and refining department; annual capacity, 10,000 tons concentrates or about 6000 tons pig tin; cost, about $350,000; to be ready about April, 1918.

Black Mountain Mine, Whitehall, Washington County, N. Y., owned by Hooper Bros., completed mining, milling and manufacturing plant for treating 100 tons of graphite ore daily; in full operation in December, 1917.

United Gold Mining Co., Granite, Grant County, Oregon, completed 75-ton concentrating mill at cost of $40,000 on Nov. 1, 1917.

Greenback Mines Co., Placer, Josephine County, Oregon, started construction of new 50-ton wet-process concentrating plant, at estimated cost of $60,000, to be completed in August, 1918.

Donora Zinc Co., Donora, Washington County, Penn., completed zinc-oxide plant, in March, 1917.

Spokane Lead and Silver Co., Custer, Custer County, S. D., started construction of 50-ton concentration mill; nearly completed.

Refinite Co., Ardmore, Fall River County, S. D., completed plant for treatment of kaolinite.

Custer Peak Milling and Ore Co., Roubaix, Lawrence County, S. D., erected 10-stamp concentrating mill for treating copper ore; operating in September, 1917.

Deadwood Zinc and Lead Mining and Milling Co., Deadwood, Lawrence County, S. D., started construction of 10-stamp, 50-ton mill, at estimated cost of $12,000, to be completed in May, 1918.

Homestake Mining Co., Lead, Lawrence County, S. D., built hydro-electric plant, including 2000-kw. generator on Spearfish River, at site known as Manece. Estimated cost of new plant will be $500,000; to be completed in summer of 1918.

New Puritan, Deadwood, Lawrence County, S. D., in Strawberry Gulch erected boarding house and installed machinery purchased from Wasp No. 2.

Oro Hondo Mine, Deadwood, Lawrence County, S. D., installing large hoisting engine purchased from Alaska Treadwell.

Trojan Mining Co., Trojan, Lawrence County, S. D., installed ball mill for fine grinding and enlarged slime plant; installing Portland filters; capacity to be 400 to 500 tons daily. Mining equipment erected at the Republic, on Blacktail Gulch, and to be erected at Two Johns property recently purchased.

U. S. Gypsum Co., Piedmont, Meade County, S. D., completed 100-ton furnace and plaster mill; now in operation.

Home Lode Gold Mining Co., Silver City, Pennington County, S. D., completed 30-ton amalgamation-concentration plant to be enlarged during 1918.

Freeport Sulphur Co., Freeport, Brazoria County, Texas, completed construction of power plant, No. 4.

Southwestern Graphite Co., Burnet, Burnet County, Texas, built mill at old property of the Texas Graphite Co.

Dixie Graphite Co., Llano, Llano County, Texas, completed remodeling of plant.

Utah Fuel Co., Sunnyside, Carbon County, Utah, built 112 new coke ovens, and three concrete-and-steel change houses for employees at Sunnyside and Castlegate; also built numerous houses for employees and made general improvements.

Tintic Drain Tunnel Co., Eureka, Juab County, Utah, constructed boarding and bunk houses, and blacksmith shop.

Deer Trail Mining Co., Marysvale, Piute County, Utah, constructed 100-ton mill using cyanidation and flotation, to be in operation about Jan. 1, 1918, on gold-silver-lead ore.

Florence Mining and Milling Co., Marysvale, Piute County, Utah, constructing leaching and refining department at its alunite-calcining plant; output of 48 to 50 tons calcined potash daily.

Mineral Products Co., Marysvale, Piute County, Utah, started rebuilding potash plant partially destroyed by fire last October.

Ohio Copper Co., Lark, Salt Lake County, Utah, started construction of 3000-ton flotation plant, to be completed about April, 1918; includes five 600-ton Minerals Separation units; 10, 8 ft. x 36-in. Hardinge ball mills, nine Dorr thickeners and five 20 x 6-ft. Dorr classifiers.

Utah Copper Co., Garfield, Utah, completed leaching plant of 4000-ton initial daily capacity about Jan. 1, 1918; added new crushing equipment including large gyratory crushers and new ball mills at Magna and Arthur mills; installed 250-ton Janney flotation unit in Arthur mill treating at present up to 6000 tons per day in new flotation part of mill; also completed other extensive alterations and improvements at both mills.

Big Indian Copper Co., Lasal, San Juan County, Utah, started construction of 300-ton leaching mill 36 miles east of Moab.

Judge Mining and Smelting Co., Park City, Summit County, Utah, completed electrolytic-zinc plant for treating 50 tons of concentrates daily on Feb. 1, 1917; 12- to 15-ton output of zinc per day.

Fissures Exploration Co., McCormick Block, Salt Lake City, Utah, completed 100-ton mill at Pacific mine at American Fork, Utah County.

Lone Pine-Surprise Consolidated Mining Co., Republic, Ferry County, Wash., completed buildings, headframe, two carpenter shops and installed hoist, boiler and compressor, at cost of $39,000.

Sterling Silver, Metaline Falls, Pend Oreille County, Wash., started increasing mill capacity to 50 tons daily.

American Mineral Production Co., Valley, Stevens County, Wash., started installation of calcining plant to treat 9000 tons monthly of crystalline magnesite.

Northwest Magnesite Co., Chewelah, Stevens County, Wash., constructing 325-ton plant for quarrying and calcining magnesite, at estimated cost of $200,000; to be completed March, 1918.

Northport Smelting and Refining Co., Northport, Stevens County, Wash., constructing 900-electrode Cottrell precipitation plant; building to be 150 x 75 ft. and about 85 ft. high.

United Zinc Smelting Corporation, Moundsville, Marshall County, W. Va., completed construction of zinc smeltery, including 1728 retorts.

Wisconsin zinc district had 11 concentrating mills built, or moved and reconstructed, as follows: North Survey (Dodgeville), New Empire and New Rose No. 2 (Platteville), C. S. H. (Cuba City), Mud Range (Potosi), Copeland (Shullsburg), Jefferson (Hazel Green), Hird No. 3, Barecat, Haskins and Ida Blende (Benton-New Diggings).

Canada Copper Corporation, Ltd., Princeton, B. C., started design and lay-out of 3000-ton concentrator, estimated cost of $750,000; to be completed in about two years.

Granite-Poorman Mine, Nelson, B. C., Canada, started installation of new 1500-cu.ft. compressor plant; mill to be improved later.

Consolidated Mining and Smelting Co. of Canada, Ltd., Trail, B. C., completed electrolytic zinc plant of 60 to 70 tons daily capacity when working on high-grade ore; 10-ton copper refinery doubled in capacity; additions made to lead smeltery; concentrator for testing purposes built.

Bourke's Mines, Bourke's Station, Ontario, Canada, completed camp buildings and mining plant.

British America Nickel Corporation, Ltd., Sudbury, Ontario, Canada, started construction of smelting and refining works at Nickelton, near Sudbury; capacity 3000 tons refined copper and 6000 tons refined nickel yearly; estimated cost, $3,000,000. Ground broken in June, 1917; to be completed in July, 1919.

International Nickel Co., 43 Exchange Place, New York, practically completed refinery at Port Colburne, Ont., for refining nickel; capacity, 10,000 tons nickel per year and corresponding quantity of copper; $5,000,000 is about the estimated cost.

Casey Cobalt Silver Mining Co., Ltd., New Liskeard, Ontario, Canada, started construction of new mill to replace 30-stamp mill destroyed by fire.

Coniagas Mines, Ltd., Cobalt, Ontario, completed 180-ton flotation plant treating silver ore.

Hollinger Consolidated, Timmins, Ontario, Canada, increased mill capacity from 1800 tons daily to 2800 tons, at estimated cost, including additional power and central-shaft equipment, of $1,000,000.

Lake Shore Mines, Ltd., Kirkland Lake, Ontario, Canada, constructing new 100-ton mill to be completed early in 1918.

National, Cobalt, Ontario, Canada, completed 100-ton flotation plant.

National Potash Corporation, Gravenhurst, Ontario, Canada, started erection of potash plant of 36-ton daily capacity.

Nipissing, Cobalt, Ontario, Canada, increased flotation equipment to eight callow rougher and two cleaner cells from five roughers and one cleaner, increasing capacity to 250 to 300 tons per day.

Parson Claims, Munro Township, Ontario, Canada, acquired by Mill Gold Mining Co., erected camp buildings; installing mining plant.

Pittsburgh-Lorrain, South Lorrain, Ontario, Canada, overhauled Wettlaufer mill for treatment of low-grade ore.

Port Arthur Copper Co., Mine Center, Ontario, Canada, installed mining plant including air compressors.

Provincial, Cobalt, Ontario, Canada, completed extension for Hardinge mill, slime tables, classifier and slime tank with Groch, 40-ton, oil-flotation machine.

Schumacher Gold Mines, Ltd., Schumacher, Ontario, Canada, started construction of addition to cyanide plant increasing crushing capacity from 200 to 300 tons; building completed.

Sylvanite Gold Mines, Ltd., Kirkland Lake, Ontario, Canada, started construction of gold-mining plant, including five-drill compressor, hoist and 60-hp. boiler; stopped work June 1, because of shortage of funds.

Tip Top Mining Co., Port Arthur, Ontario, Canada, started construction of 40-ton copper-mining plant, in Thunder Bay district, including railway, 6½ miles long, at estimated cost of $200,000.

Wright Hargreaves, Kirkland Lake, Ontario, Canada, completed installation of new 12-drill compressor, 200 hp. motor and other mining equipments.

Mining Stocks on the New York Stock Exchange

Company	1914 High	1914 Low	1915 High	1915 Low	1916 High	1916 Low	First	Range Year 1917 High	Date	Low	Date	Last	Total Sales
Alaska Gold Mines (*d*)	28⅞	19⅛	40⅛	21¼	26⅛	10¼	11⅜	11⅛	Jan. 4	1	Dec. 20	1⅜	233,400
Alaska Juneau Gold Mining (*d*)	...	...	13⅛	9⅜	10¼	6¼	7⅛	8⅛	Mar. 26	1⅜	Dec. 19	2⅛	125,974
Allis-Chalmers Mfg.	14¼	6	49⅜	7⅞	38	19	27	32⅜	May 31	15	Dec. 17	18¼	375,660
Allis-Chalmers Mfg. pf.	49	32½	85⅛	33	92	70½	85½	86⅞	Mar. 10	65	Dec. 13	72⅜	61,550
Amer. Smelt. and Ref. Co.	71⅛	50¼	108⅛	56	123⅜	88½	104⅜	112⅜	June 2	67⅝	Dec. 12	78⅛	2,726,615
Amer. Smelt. and Ref. Co. pf.	105	97⅜	113	100	118⅛	109¼	114⅞	117⅛	Jan. 19 (*h*)	99½	Nov. 14	101⅝	35,941
American Smelters pf. A	...	...	92	86	102	91⅜	98⅜	102½	Mar. 10	90½	Dec. 18	92	33,344
American Smelters pf. B	85	79½	85⅜	78	97⅛	84½	94	99⅛	Jan. 31	90⅜	May 25	91⅛	31,327
Amer. Zinc, Lead and Smelt. (*b*)	21⅛	12¼	71⅛	67⅛	97⅝	29⅜	38⅛	41⅜	Jan. 26	10⅛	Dec. 26	14	192,950
Amer. Zinc, Lead & Smelt. pf. (*b*)	...	...	71⅛	67¼	87	59⅛	72	72⅛	Jan. 26	39⅛	Dec. 28	41	28,160
Anaconda Copper Mining Co. (*a*)	38¼	24¼	91¾	49½	105⅜	77	82⅜	87	May 26	51⅛	Nov. 8	61⅜	2,768,609
Batopilas Mining (*c*)	1½	⅜	4½	⅜	3⅜	⅜	1⅞	2¼	Sept. 22	⅛	June 20	1⅛	75,812
Bethlehem Steel Co.	46⅜	29½	600	46¼	700	415	510	515	Jan. 4	66½	Dec. 20	74½	195,295
Bethlehem Steel, Class B, com.	...	...	...	...	...	...	129	156	June 11 (*h*)	66½	Dec. 14	75½	505,160
Bethlehem Steel Co. pf.	91⅜	68	184	91	186	126	135	135	Jan. 5	84	Oct. 5	90	18,750
Butte & Superior (*d*)	...	...	79⅞	53	105¼	41⅞	48	52¼	Jan. 26	12⅜	Dec. 20	16½	280,575
Cerro de Pasco, (*g*)	...	...	...	...	...	...	39½	41	Feb. 20	25	Dec. 20	31	128,966
Chile Copper.... (*b*)	...	...	26⅜	23⅜	39¼	19⅜	25⅝	27⅛	Mar. 12	11¼	Nov. 5	17	670,335
Chino Copper (*e*)	44	31⅜	57⅜	32¾	74	46⅛	55⅜	63¾	Mar. 7	35⅜	Nov. 8	42⅜	773,575
Colorado Fuel and Iron	34½	20½	66⅜	21¾	63½	38⅛	46⅜	58	June 7	29⅜	Nov. 8	36⅜	480,275
Con. Inter. Callahan	...	...	...	...	28½	18	21	21	Jan. 3	7	Dec. 28	7	11,900
Dome Mines	18	6½	30⅛	16	29½	18	21	24⅜	Jan. 9	6½	Nov. 17	8¼	153,423
Federal Min. and Smelt.	15	7½	60	8	35	12⅝	14	26½	Aug. 6	8¼	Dec. 17	12	13,145
Federal Min. and Smelt. pf.	43	28⅜	65	20	57½	35⅜	40⅛	54¾	July 31	28	Dec. 12	35¾	35,860
General Chemical Co.	180	160	360	165	350	285	249	250	Jan. 15	153	Dec. 13	155	4,724
General Chemical Co. pf.	110	107½	116	106	117	113½	112⅛	113	Apr. 25	100	Nov. 22	100	1,707
Granby Consolidated	91	60	91	79½	120	80	89	92⅜	Jan. 17	65	Nov. 5	78	55,980
Great North. ctfs. for ore prop.	39½	22½	54	25¼	50⅜	32	36½	38⅛	Mar. 4	22⅜	Nov. 5	27	1,029,164
Greene Cananea	42½	21	52⅜	37	56½	34	46	47	Jan. 26	34	Nov. 16	38	78,423
Homestake Mining	120½	109⅜	124	116	135½	126½	127½	131½	Jan. 29 (*h*)	89	Dec. 20	93	2,769
Inspiration Con. Cop. (*c*)	19¼	14¼	47⅛	16⅝	74⅜	42⅜	58	66½	June 11	38	Nov. 8	47	2,039,140
International Nickel v. tr. ctfs. (*f*)	...	...	223½	179⅜	56⅜	38⅞	42⅛	47⅜	Mar. 21	24½	Dec. 13	30½	7,410,150
Internat. Nickel pf. (*f*)	...	...	110	105½	111⅜	105	107⅞	108	Jan 6	92	Nov. 15	92	2,535
Kennecott Copper (*g*)	...	...	59⅛	25	64¼	40	46	50⅛	May 26	26	Nov. 5	32⅜	1,971,559
Lackawanna Steel Co.	40	26½	94¾	28	107	64	84½	103⅞	June 13	68	Nov. 5	77	1,066,850
Miami Copper (*e*)	24⅜	16½	36⅝	17¼	49⅜	33	41	43½	Apr. 30	25	Nov. 5	29½	493,811
National Lead Co.	52	40	70⅜	44	74⅝	57	60	63¼	Mar. 23	37⅞	Dec. 20	44¼	89,750
National Lead Co., pf.	109	105	115	104⅜	117⅞	111¼	112	114	Jan. 6	99	Dec. 5	99	10,147
Nevada Con. Copper Co. (*e*)	16½	10⅛	17	11⅜	34⅛	15	24½	26⅜	June 11	16	Nov. 5	18½	405,495
Ontario Silver Mining	2¾	2¼	12⅜	2	11⅜	5¾	6	7¾	Sept. 21	3⅜	Nov. 8	5	138,035
Pittsburgh Steel pf.	93	82	102½	74	106	93½	102	102	Jan. 9	87	Dec. 4	89½	12,559
Quicksilver	2⅞	⅞	5⅜	⅛	6	2	2⅛	3	Feb. 14	⅛	Nov. 21	1	24,200
Quicksilver pf.	4	1⅜	6⅞	⅜	8⅜	3½	4½	4½	Feb. 10	¼	Nov. 23	⅞	21,100
Ray Consolidated Copper (*d*)	22½	15	27⅛	15¼	37	20	26½	32⅛	Apr. 3	19½	Nov. 7	23⅛	1,187,610
Republic Iron and Steel Co.	27	18	57⅛	19	93	42	79⅜	94½	June 7	60	Feb. 1	79⅜	2,804,520
Republic Iron and Steel Co. pf.	91½	75	112⅜	72	117	101	105⅜	105⅞	May 25	89	Dec. 20	....	40,535
Shattuck Arizona Copper (*d*)	29⅜	18	38	18⅜	40½	22	27	29⅜	Mar. 9	15	Dec. 20	(*h*) 16½	130,535
Sloss-Sheffield Steel and Iron	35	19½	66⅞	24	93½	37	66½	74⅜	Mar. 30	33½	Nov. 7	40	248,750
Sloss-Sheffield Steel and Iron pf.	92	85	102	85	103½	91½	96½	99	Feb. 5	88½	Sept. 25	88½	4,025
Tennessee Cop. & Chem. (*g*)	...	...	...	...	19½	15¾	16⅜	19½	June 20	11	Nov. 9	12¾	273,426
United Alloy Steel (*g*)	...	...	...	...	...	...	44	49⅜	June 2	34½	Dec. 20	36	186,950
U. S. Smelt., Ref. & Min. (*a*)	43⅜	24¼	....	....	81½	57	64⅜	67⅜	Jan. 4	40	Dec. 20	45	202,975
U. S. Smelt., Ref. & Min. pf. (*a*)	48⅜	40¼	...	...	53½	50	52¼	52¼	Jan. 3	43⅜	Nov. 9	45	10,977
U. S. Steel Corporation	67¼	48	89¼	38	129¾	79⅜	108	136⅛	May 31	79⅛	Dec. 20	90⅜	43,965,840
U. S. Steel Corporation pf.	112⅜	103¼	117	102	123	115	119⅜	121⅛	Jan. 19	102⅜	Dec. 20	108	319,119
Utah Copper (*d*)	59⅜	45⅜	81⅛	48⅛	130	74¾	105½	118⅜	May 25	70⅛	Dec. 17	81⅛	9,739,735
Vulcan Detinning	...	...	19	5	10⅜	7	7	10⅛	May 17	6	Apr. 14	7	1,520
Vulcan Detinning pf.	35	21	43	21	26⅜	20½	20	24⅜	May 18	20	May 17	23⅛	910

Highest and lowest prices of the year are based usually on sales of 100 shares. (*a*) Par $50. (*b*) Par $25. (*c*) Par $20. (*d*) Par $10. (*e*) Par $5. (*f*) Par value of common stock reduced from $100 to $25 in 1916; in 1917, voting trust certificates were exchanged for stock. (*g*) No par value. (*h*) Ex-dividend.

Mining Stocks in 1917

THE stock market of 1917 was characterized by general declines, which in November took many stocks to phenomenally low figures, even below those registered in July, 1914. At the end of the year there was a reversal in sentiment and a rally in the market which carried the leaders—Anaconda and Utah—up about 10 points, and other stocks in proportion.

The accompanying tables show the quotations and transactions on the New York and Boston Stock Exchanges and the New York Curb.

With reference to the table of Curb quotations, it should be noted that these are not official, although they are probably as reliable as can be obtained. On the New York Stock Exchange every precaution is taken to insure that quotations are authentic; on the Curb, however, there are no restrictions whatever, and anyone can make prices and have them recorded in the published lists. It is, therefore, impossible to vouch for the trustworthiness of the prices, and they are printed merely as a matter of record.

MINING STOCKS ON THE NEW YORK CURB—1917

Company	Open	High	Low	Last	Sales
Adanac Silver	(a) 22	22	20	20	7,000
Aguacate Mine	1	2	(a) 5	8	6,290
Alaska-Brit. Col. Mining					1,339,230
Alaska Mines Co					828,628
Alaska Zinc and Copper					6,000
Am. Commander	(a) 8	11	3	4	426,400
Ariz. Binghamton Copper	5	6	3	3	14,575
Ariz. Chloride	(a) 44	1			881,510
Ariz. Copperfields					71,800
Arizona Cornelia		1		1	306,090
Ariz. United	(a) 55	55	32	32	26,700
Atlanta	(a) 10	20	7	9	1,484,200
Atlas Copper					122,200
Austin Amazon	1	1			343,360
Barnes King Development	1	1	1	1	100
Beaver Cobalt	(a) 48	48	48	48	500
Big Jim	1	1			234,570
Big Ledge Copper	3	6	1	1	1,214,738
Bingham Mines	12	13	9	11	15,500
Bisbee Copper		1			492,910
Booth	(a) 10		3	4	152,350
Boston Creek	1	1	1	1	209,500
Boston and Montana Dev	(a) 77	82	37	45	1,505,200
Bradshaw Copper	1	2		1	73,835
Buffalo Mines	1	1	1	1	25,800
Butte Copper and Zinc	11	14	5	7	459,300
Butte-Detroit	1	2			524,610
Butte-New York	1	2			56,360
Calaveras Copper	5	5	1	1	5,300
Caledonia Mining	(a) 50	78	36	46	1,122,950
Calumet & Jerome	1	2	1	1	1,752,280
Canada Copper	1	3	1	1	514,200
Canada Copper, rts	(a) 10	3	1	2	252,650
Carlisle Mining	5	6	4	4	62,675
Cashboy	(a) 7	16	3	4	1,329,600
Cerbat Silver M. M	(a) 36	44	34	39	68,900
Cerro Gordo Mining	2	2	1	1	38,300
Con. Ariz. Smelting	1	2	1	1	1,138,580
Consolidated Coppermines	3	12	3	6	335,172
Cons. Gold Mines	(a) 60	70	35	70	10,400
Con. Nev. Utah					18,000
Cresson Gold	7	7	2	4	262,745
Crystal Copper	(a) 99	1	(a) 66	75	141,025
Darwin Mines Development	11	12	1	1	2,325
Davis-Daly	6	7	5	5	1,400
Denbigh Mines	1	2	2	2	109,660
Dome Extension	(a) 16	18	16	18	4,500
Duncan M. and M	2	2			26,350
Dundee-Ariz	1	2			76,102
Eastern Copper	(a) 52	57	51	55	389,450
Ely Consolidated	(a) 15	(a) 19	10	10	328,400
Emma Copper	1	2			3,015,123
First National Copper	3	3	1	1	67,898
Ferber Copper	(a) 50	63	50	61	142,450
Fortuna Consolidated	(a) 14	44	12	40	421,100
Gibson Consolidated Copper	2	2	2	2	111,368
Gila Cannon	(a) 75	75	50	50	40,600
Gila Copper	16	17	16	17	26,025
Goldfield Cons	(a) 72	(a) 77			583,456
Goldfield Merger	(a) 6	10	3	3	537,080
Gold Hill	(a) 10	12	3	4	17,200
Gold Warrior Mining	(a) 60	74	60	68	40,700
Green Monster	2	2			1,192,150
Hargraves Mining	(a) 15	25	10	14	1,364,500
Hecla Mining	8	9	3	4	343,150
Hollinger G. M	5	5	5	5	200
Howe Sound, w. i	8	8	3	4	23,260
Hudson Bay Zinc	1	1			81,480
Inspiration Needles Co					84,235
Int. Mines	(a) 9	20	6	15	527,475
Inter. Mt. Mines Dev	1	1	1	1	1,800
Iron Blossom	1	1		21–32	143,795
Jerome Verde	1	3			3,244,900
Jerome Victor	2	2			27,850
Jim Butler	(a) 86	1	(a) 69	77	437,617
Josevig-Kennecott					217,775
Jumbo Extension	(a) 27	49	13	15	716,300
Jumbo Mining of N. M		3		3	176,050
Kerr Lake	4	6	4	5	14,766
Kewanas	(a) 19	27	4	5	290,701
Kirkland P. G. M	(a) 50	50	50	50	89,000
La Rose Consolidated					153,000
Lavelle Gold	1	1		1	9,700
Loma Prieta	1	1	1	1	149,950
Loon Lake	(a) 48	71	40	61	50,875
Louisiana Consolidated	(a) 90	1			1,914,650
Magma Chief					257,908
Magma Copper	40	59	31	42	196,150
Magmatic Copper	(a) 31	54	17	21	234,095
Magnate Copper	(a) 75	1			502,665
Majestic Mines		1			82,980
Marsh Mining	(a) 10	23	5	6	912,450
Marysville Gold		1		1	191,450
Mason Valley		6	3	5	364,400
McKinley-Darragh	(a) 50	75	46	59	218,800
Miami Merger	(a) 40	2			332,800
Milford Copper	(a) 95	2	(a) 90	1	471,450
Mojave Tungsten		1			137,795
Mohican Copper		1			273,800
Monster Chief				3–32	1,151,728
Montana Gold	(a) 81	81	40	75	24,300
Mother Lode	(a) 43	46	25	27	1,722,300
National Leasing	(a) 19	30	5	6	1,797,500
Natl. Zinc and Lead	(a) 54	76	25	27	1,162,500
New Cornelia		15	15	14	15	20,156
N. Y. & Hon. R. C. M		16	16	12	12	3,175
Nevada Ophir Mining	(a) 25	25	15	20	92,200
Nevada Rand		10	14	9	13	63,000
Newray Mines		1	1			315,650
New Utah Bingham						25,700
Nicklas Mining		1	2			70,850
Nipissing		8	9	6	8	168,600
Nixon-Nevada	(a) 76	1	(a) 25	1	1,067,000
Ohio Copper		1	1	1	39,600
Ohio Copper, new, w. i		1	1		1	1,201,600
Old Emma Leasing	(a) 55	68	25	41	1,009,310
Peabody Con. Cop		1	2	1	2	5,600
Pitts. Idaho		1	1	1	1	7,000
Pole Star Copper	(a) 20	22	20	22	13,000
Portland Con. Copper		1	(a) 22	33	986,500
Progress Mining and Milling					254,700
Rawley Mines		1	1	1	14,000
Ray Hercules		4	2	3	77,980
Rex. Consolidated Mining	(a) 50	58	8	11	1,297,600
Richmond Copper		1	(a) 48	62	191,550
Rochester Mines	(a) 65	72	28	31	557,450
Round Mountain	(a) 40	47	26	26	10,441
Sacramento Valley Copper		1	1	1	116,425
Sagamore Mining Co	(a) 81	1.9-32	(a) 81	1	70,400
San Toy	(a) 15	20	11	11	119,350
Santa Rita Dev					61,936
Section Thirty	10	14	6	6	24,540
Seneca Copper	15	16			97,355
Senorito Copper	1	2	1	1	253,350
Silver King of Ariz					1,088,225
Silver King Consolidated	4	4	2	3	42,765
Silver Pick	(a) 23	26	5	5	300,020
Slocum Star	(a) 24	25	18	18	28,710
St. Nicholas Zinc			(a) 5	8	433,026
Standard Silver Lead		3	7–32		192,850
Stewart	9–32				341,050
Success Mining	(a) 42	60	8	9	681,260
Superior & Boston	6	7	3	3	10,265
Superior Copper	1	2	1	2	49,600
Teck Hughes	(a) 66	83	66	83	8,000
Tom Reed	1	2	1	2	28,610
Tommy Burns	(a) 30	70	14	21	737,650
Tommy Burns G.M., pf	1	2	1	1	401,300
Tonopah Belmont	4	5	2	3	32,950
Tonopah Extension	4	4	1	1	303,795
Tonopah Mining	5	7	3	3	20,292
Tri-Bullion					215,050
Trinity Copper	7	8	6	7	11,720
Troy-Arizona	(a) 53	70	14	15	639,350
Temiskaming	(a) 42	42	42	42	1,000
Tuolumne Copper	2	2	1	1	62,100
United Magma	(a) 56	57	15	15	231,100
United Mines of Ariz	1	1			473,556
United Eastern	5	5	3	3	94,308
United Copper Mining					82,840
U. S. Tungsten	(a) 22	29	7	7	403,630
United Verde Extension	38	41	31	38	138,400
United Zinc	4	6	4	4	52,147
Unity Gold	3	4	2	3	121,750
Utah Apex	3	3	3	3	1,050
Utica Mines	(a) 30	30	8	11	671,950
Utah National Mining	(a) 65	7			652,630
Virginia Mine	1	1		1	18,625
West End Consolidated	(a) 67	84	60	68	302,040
Wettlaufer Silver	(a) 10	10	4	5	14,800
White Caps Mining	(a) 35	2	(a) 34	15–32	1,305,920
White Caps Extension	(a) 32	33	5	9	239,650
Wilbert Copper	(a) 21	33	14	17	419,950
Whiteoaks Mining	4	5	2	2	4,555
Yerington Mt. Copper	(a) 25	60	11	12	2,079,708
Yukon Gold	2	2	1	1	2,900
Yukon Alaska	(a) 22	22	22	22	200

(a) Cents per share.

Bonds on New York Stock Exchange

	1916 High	1916 Low	1917 High	1917 Low	1917 Last	Sales in $1,000
Alaska Gold M., 6% conv., '25, Series A	117	85	85	14	20	153
Alaska Gold M., 6% conv., '26, Series B	105	84⅞	84⅞	14	18	127
Am. Sm. & Ref., 1st 30-yr. 5's, Series A, 1947	....	....	92⅜	84	86½	2,113½
Beth. Steel, 1st ext. 5's, 1926	104½	102½	104	93¼	97¼	647
Beth. Steel, 1st and ref. 5's, 1942	103⅛	99¼	102	86½	87½	829
Braden Copper, coll. tr. 6's, 1931	99½	97½	98	81	89	415
Cerro de Pasco, 10-yr. conv. 6's, 1925	....	....	118	100½	101½	1,122
Chile Copper, conv. 7's, 1923	154	120½	132	96	103	3,305
Chile Copper, conv. 6's, 1932	....	....	101	70	77	1,412
Chile Copper, conv. 6's, 1932 full paid	....	....	100⅜	80	80	560
Granby Consol., conv. 6's, '28	117	101⅛	109½	94¼	94½	294
Illinois Steel, deb. 4½'s, 1940	94⅛	89½	94	81	81	1,916
Indiana Steel, 1st mtg., 5's, 1952	105	101½	103½	94	95	1,446
Lacka. Steel, 1st conv. 5's, 1923	101½	97½	101⅛	94⅛	96	1,174
Lacka. Steel, 1st conv. mtg. 5's, Series A, 1950	100	90	107½	83½	86½	6,514
Nat'l Tube, 1st mtge. 5's, 1952	102⅛	99⅛	103	94	94½	876
Republic I. & S. 10-30-yr. s. f. 5's, 1940	102½	95⅞	101¼	93	93¾	2,768
Tenn. C. I. & R.R., 1st 5's, 1951	103⅜	100¼	103¼	95	95	66
Tenn. Copper, 1st conv. 6's, 1925	125	88	101¼	87½	87½	356
U. S. Sm., Ref. & M., conv. 6's, 1926	115¼	107	109	94⅛	96	681
U. S. Steel, 10-60 yr., s. f. 5's, 1963	107⅛	103⅜	107⅛	93¼	98	14,492
Va. Iron C. & C., 1st 5's, 1949	90½	82½	90	85	90	207

Mining Stocks on Boston Exchange

	High	Date	Low	Date	Last
Adventure	4¼	Jan. 2	1	Oct. 26	1⅛
Ahmeek	108	Jan. 2	70	Dec. 22	80
Algomah	1¼	Jan. 2	¼	Sept. 12	¼
Allouez	70	Mar. 6	45	Dec. 19	50
Arizona Commercial	15¼	June 11	8½	Nov. 5	11⅛
Butte Ballaklava	2½	Jan. 26	¼	Dec. 24	25c.
Calumet & Arizona	85¼	Jan. 26	55	Dec. 19	65
Calumet & Hecla	590	Feb. 20	411	Dec. 20	428
Centennial	27¼	Jan. 16	11	Dec. 13	14
Copper Range	68	Jan. 17	39½	Dec. 13	46⅜
Daly West	3	Jan. 12	1½	Apr. 23	2
East Butte	16	Jan. 3	8½	Dec. 12	9⅞
Franklin	9	Mar. 6	4	Dec. 24	4½
Hancock	20½	Jan. 19	7	Dec. 20	9½
Indiana	4	Mar. 22	⅞	Dec. 18	75c.
Island Creek	76½	June 18	52	Nov. 7	53
Island Creek, pfd.	94	Apr. 28	80	Nov. 19	....
Isle Royale	36	Jan. 18	20	Dec. 13	26
Kerr Lake	6	Aug. 22	4½	Apr. 9	5
Keweenaw	4⅜	Jan. 27	1¼	June 8	1½
Lake	18	Jan. 2	5	Oct. 31	7
La Salle	5	Jan. 16	1½	Dec. 26	1⅞
Mason Valley	8⅜	Aug. 2	4½	Nov. 9	5
Mass Consolidated	15½	Jan. 17	5	Nov. 1	6½
Mayflower-Old Colony	3	May 23	1	Nov. 7	1⅜
Michigan	5½	Mar. 24	1⅜	Aug. 20	1⅜
Mohawk	98	Jan. 3	57	Dec. 4	64⅜
New Arcadian	6	Jan. 2	1½	Dec. 14	2
New Idria	17½	Apr. 3	10	Nov. 7	13⅞
Nipissing	9⅜	Sept. 26	6¾	July 2	8⅞
North Butte	24¼	Mar. 28	11¾	Oct. 18	14½
North Lake	2⅜	Jan. 3	30c.	Nov. 20	50c.
Ojibway	2⅞	Jan. 12	98c.	Dec. 27	99c.
Old Dominion	67¾	Mar. 12	33	Nov. 7	43¼
Osceola	95	Mar. 12	53½	Dec. 20	59¼
Quincy	94½	Feb. 21	60	Nov. 7	69½
St. Mary's	89⅞	Mar. 6	48	Dec 11	55
Santa Fe	2	Jan. 2	58c.	Dec. 28	60c.
Shannon	10	Jan. 5	5⅛	Oct. 18	5½
South Lake	6½	Jan. 2	89c.	Dec. 28	1⅝
So. Utah M. & S.	31c.	Jan. 26	10c.	Dec. 17	10c.
Superior	16⅝	Mar. 6	3½	Dec. 17	4¾
Superior & Boston	8¼	Jan. 6	2¾	Dec. 12	3½
Trinity	8½	July 11	3	Nov. 19	3⅞
Tuolumne	2 5/16	Jan. 9	1	May 12	1 7/16
Utah Apex	3¼	Sept. 27	1⅞	Mar. 28	2⅛
Utah Consolidated	21½	Feb. 20	9½	Dec. 14	10⅜
Utah Metal and Tunnel	6⅜	Jan. 16	2½	Dec. 29	2½
Victoria	6	Jan. 2	2	Oct. 22	3
Winona	5⅛	Jan. 25	2	Oct. 8	2
Wolverine	53½	Mar. 3	31	Dec. 18	34½
Wyandot	2⅜	Jan. 3	15c.	Aug. 23	⅜

Coal Production in 1917

The output of bituminous coal in the United States in 1917 was 544,142,000 short tons, according to the U. S. Geological Survey, or 8.3% more than the 1916 output. The production of anthracite was between 90,000,000 and 100,000,000 short tons.

Though production increased, demand outstripped it and the year was characterized by frequent coal shortage, actual and threatened. Bad transportation conditions prevailed throughout. Early in the year, anthracite stocks were forced to their lowest point since 1902. A spring rush to buy coal for the winter maintained the demand, in the face of which the usual April reductions in price were ordered by the Federal Trade Commission. Traffic was opened on the Great Lakes on Apr. 16, earlier than usual, owing to coal shortage in the Northwest. On June 28 coal prices were agreed upon by the coal committee of the National Defense Council and the operators at a reduction of about one-third, which agreement was repudiated by Secretary of War Baker. Anthracite shipments in mid-July broke all records. On Aug. 21 the President fixed the base price of bituminous coal at approximately $2 per short ton at the mine, though operators had asked for a $3 base price. On Aug. 24 the appointment of Dr. Harry A. Garfield as Fuel Administrator was made. The price of anthracite was also fixed at $4 to $5.30 per ton according to locality and size.

Strain on transportation facilities began to show in the latter part of July. Price-fixing had little effect on production and distribution of anthracite but caused a decline in bituminous output. Wages were raised in the central competitive field on the condition that higher coal prices be allowed. However the bituminous situation rapidly became critical in October due to cool weather, large Government requirements and heavy confiscation by railroads in addition to the existing evils. On Oct. 29 the President allowed an increase of 45c. per ton in the price of bituminous coal at practically all mines in the country, following this on Dec. 1 with an increase in the price of anthracite of 35c. per ton, to meet a proposed wage increase for anthracite miners. This, however, did not increase the available supply materially. Pooling of output and priority shipment were resorted to without result. Traffic conditions were already bad and with the sudden advent of cold and snow in December transportation became thoroughly demoralized. New York and New England faced a coal famine. Strenuous efforts of the Administration to restore order, culminating in taking control of the railroads, featured the closing days of 1917. At the end of December, production of bituminous coal was recovering from the extraordinary depression of the middle of the month, averaging 1,793,000 short tons per working day during Christmas week.

Necrology

Among the noted men identified with mining and metallurgical industries who died during 1917 were:

Charles J. Moore	Jan. 28	Arnold Hague	May 14
John Adams Church	Feb. 12	John C. Bridgman	May 28
Hermann A. Keller	Feb. 16	Robert Bell	June 18
Edward Dyer Peters	Feb. 17	K. Birkeland	June 18
David H. Browne	Mar. 30	William Bullock Clark	July 27
Frank S. Witherbee	Apr. 13	Eugene Franz Roeber	Oct. 17
Anton Eilers	Apr. 22	George T. Holloway	Oct. 24

Data of the World's Principal Mines

By S. F. SHAW*

Compiled from Annual Reports of the Respective Companies

Name	Situation	Year	Tons	Profit	Dividends	Reserves, Tons	Price per Ton	Yield	Cost per Ton
Abosso Gold	Tran.	'15-'16	113,300	£25,023	£20,000	.....	$7.69		$6.56
Ahmeek	U. S.	1916	1,154,010	3,449,710	2,800,000	.....	5.33		2.39
Alaska Gold Mines	Alaska	1916	1,892,788	451,026	.....	.....	1.19		0.96
Alaska Juneau	Alaska	1916	180,113	.....	.....	.....	.....		.....
Alaska Mexican	Alaska	1916	175,476	64,236	.....	.....	1.57		1.51
Alaska Treadwell	Alaska	1916	671,378	658,119	250,000	.....	.....		1.36
Alaska United	Alaska	1916	285,078	167,593 (f)	.....	.....	1.92		.....
Allouez	U. S.	1916	566,960	1,524,511	900,000	.....	4.64		1.96
Amalgamated Zinc	Aus.	(a)-'16	91,438	£71,000	£150,000	.....	.....		.....
Amalgamated Zinc	Aus.	(b)-'16	171,856	£93,281	£75,000	.....	.....		.....
Amer. Zinc, Lead and Smelting	U. S.	1916	.....	9,307,967	10,259,292	.....	.....		.....
Anaconda Copper	U. S.	1916	5,589,157	50,828,372	.....	.....	.....		.....
Antelope Gold	Rhod.	1916	45,927	£5,610	.....	101,393	9.85		9.28
Arizona Copper	U. S.	'15-'16	905,486	£988,226 (g)	£328,510	.....	9.96		4.55 (g)
Associated Northern Blocks	Aus.	'15-'16	30,778	£5,363	.....	.....	9.15		8.27
Associated Gold Mines	Aus.	'16-'17	93,430	£5,544	.....	.....	6.58		6.20
Atlas Mining and Milling	U. S.	'15-'16	36,647	17,265 (g)	.....	12,000	6.77		5.38
Balaghat Gold	India	1916	28,476	£7,185 (f)	.....	.....	12.83		14.06
Banties	Tran.	1916	279,400	£9,326 (f)	.....	.....	4.98		5.14
Barnes-King Development	U. S.	1916	14,918	96,338	60,000	412,000	.....		.....
Bingham Mines	U. S.	1916	.....	119,847	.....	.....	.....		.....
Blackwater	N. Z.	1916	40,247	£12,212	£12,449	.....	9.87		8.38
Braden Copper	Chile	1916	1,362,629	6,945,765	.....	.....	8.15		2.48
Brakpan	Tran.	1916	709,300	£413,226 (g)	£339,750	3,054,000	7.51		4.68 (g)
Broken Hill North	Aus.	(a)-'16	70,200	£131,552	£120,000	.....	.....		.....
Broken Hill North	Aus.	(b)-'16	117,190	£164,203	£120,000	2,850,000	13.65		6.85
Broken Hill Blk. 10	Aus.	(b)-'16	34,914	£13,853	£5,000	.....	.....		.....
Broken Hill Blk. 10	Aus.	(a)-'17	37,258	£21,136	£10,000	.....	9.99		7.23
Broken Hill Blk. 14	Aus.	(a)-'17	3,189	£2,329	£6,500	.....	28.46		24.91
Broken Hill Proprietary	Aus.	(b)-'16	110,276	£156,430	£118,110	.....	.....		.....
Broken Hill South	Aus.	(a)-'16	92,553	.....	£120,000	.....	18.18		8.08
Broken Hill South	Aus.	(b)-'16	157,059	£255,789	£120,000	3,500,000	14.00		6.09
Brunswick Con.Gold	U. S.	1916	34,091	.....	.....	.....	5.76		5.90
Burro Mountain	U. S.	1916	257,501	.....	.....	.....	.....		.....
Burma Corporation	Burma	1916	.....	.....	.....	3,223,000	.....		.....
Butte & Superior	U. S.	1916	627,370	8,873,446	.....	1,044,850	.....		4.50 (g)
Calumet & Arizona	U. S.	1916	858,907	11,155,005	.....	125,282	.....		.....
Calumet & Hecla	U. S.	1916	3,166,274	13,240,092	.....	.....	5.16		2.62
Cam & Motor	Rhod.	'15-'16	157,028	£8,561	.....	577,281	6.78		6.28
Camp Bird	U. S.	'15-'16	25,601	£78,436	£45,473	.....	30.92		.....
Canada Copper Corporation	Canada	1916	256,784	215,304	.....	10,000,000	.....		.....
Centennial	U. S.	1916	150,617	276,546	90,000	.....	3.94		2.10
Cerro Gordo	U. S.	1916	12,789	.....	24,375	.....	.....		11.08
Champion Reef	India	'15-'16	194,311	£106,163	£104,000	375,991	12.44		9.80
Chicksan Mining Co	Chosen	1916	65,932	272,074	70,000	117,000	8.79		4.94
Chief Con	U. S.	1916	83,606	630,830	176,491	25,844	19.16		.....
Chino Copper	U. S.	1916	3,094,400	12,843,162	7,177,335	95,555,843	6.19		2.00
City & Suburban	Tran.	1916	324,332	£238,544 (g)	£170,000	602,200	8.87		5.41 (g)
Coniagas	Canada	'15-'16	.....	.....	400,000	.....	.....		.....
Cons. Arizona Smelting	U. S.	1916	103,748	859,015	.....	.....	.....		.....
Cons. Goldfields of New Zealand	N. Z.	1916	24,186	£3,717	.....	32,149	7.82		7.04
Cons. Langlaagte	Tran.	1916	627,050	£279,661 (g)	£213,750	2,174,536	6.08		3.91
Cons. Main Reef	Tran.	'15-'16	342,895	£162,931 (g)	£115,545	856,740	7.09		4.78 (g)
Cons. Mining and Smelting	Canada	'15-'16	444,017	996,496	776,338	.....	.....		.....
Copper Range	U. S.	1916	1,187,119	6,078,189	3,941,648	.....	8.09		3.06
Cordoba Copper	Spain	1916	84,800	£21,450	£20,000	142,914	11.65		10.42
Crown Mines	Tran.	1916	2,259,700	£815,630 (g)	£470,053	11,429,000	6.20		4.45 (g)
Detroit Copper	U. S.	1916	474,808	.....	.....	.....	.....		.....
Dolcoath	B. Is.	(b) 1916	37,963	14,167 (f)	.....	.....	6.46		7.30
Dolcoath	B. Is.	(a) 1917	35,174	£1,832	.....	.....	8.88		8.63
Dome Mines	Canada	'16-'17	459,530	929,922	.....	2,250,000	4.72		2.70
Durban-Roodepoort	Tran.	1916	173,674	£35,261	£25,000	135,050	4.84		3.85
Durban-Roodepoort Deep	Tran.	1916	319,200	£40,833	£11,000	1,259,300	6.30		5.67
Eagle & Blue Bell	U. S.	1916	.....	.....	89,315	.....	.....		.....
East Butte	U. S.	1916	366,057	1,565,768	.....	.....	14.13		8.46
Esperanza Smelting and Copper	Spain	1916	108,761	£51,029	£35,000	738,000	.....		.....
Esperanza, Ltd	Mex.	1916	113,921	189,850	56,250	112,000	.....		.....
Falcon Mines	Rhod.	'15-'16	218,792	£195,688	.....	862,066	11.78		7.43
Federal Mining and Smelting	U. S.	1916	.....	.....	509,409	.....	.....		.....
Ferreira Deep	Tran.	'15-'16	644,960	£458,694	£379,750	1,632,600	8.55		5.08
Franklin	U. S.	1916	267,286	.....	.....	.....	.....		.....
Frontino & Bolivia	Col.	'15-'16	25,484	£24,458	£16,339	42,200	18.34		14.10
Gaika Gold	Rhod.	'15-'16	37,795	£32,367	£34,187	89,591	11.61		7.48
Geduld Prop	Tran.	1916	322,580	£155,630 (g)	£97,000	2,150,000	7.57		5.24
Geldenhuis Deep	Tran.	1916	696,300	£169,478	£146,433	1,616,000	6.18		5.00
Glynn's Lydenberg	Rhod.	'15-'16	49,104	£36,531	£27,625	73,282	8.97		5.39
Goldfield Con	U. S.	1916	338,680	428,620	.....	85,000	6.53		5.48
Golden Horseshoe	Aus.	1916	179,340	£84,535	£75,000	709,819	10.31		8.02
Granby Con	Canada	'15-'16	1,897,251	3,819,295	.....	.....	4.92		2.79
Great Boulder Prop	Aus.	1916	175,787	£246,333	£262,500	439,677	14.47		7.65
Grenville	B. Is.	(b) 1916	22,207	£9,919 (f)	.....	.....	5.30		7.46
Grenville	B. Is.	(a) 1917	21,013	£10,046 (f)	.....	.....	5.64		7.97
Hampden & Cloncurry	Aus.	(b) 1916	50,693	£143,816	£70,000	299,000	35.36		21.54
Hollinger	Canada	1916	604,062	3,006,409	3,126,000	.....	8.84		4.03
Inspiration	U. S.	1916	5,353,880	20,629,489	8,548,050	91,789,120	5.74		1.76
Isle Royale	U. S.	1916	925,419	1,396,655	750,000	.....	3.47		2.05
Ivanhoe	Aus.	1916	240,050	£119,279	£105,000	1,002,096	7.73		5.31
Jibutil Gold Mining	India	'15-'16	35,700	.....	.....	24,300	5.27		.....
Jim Butler-Tonopah	U. S.	'15-'16	52,142	359,387	343,604	19,158	19.78		10.80
Jupiter	Tran.	1916	269,900	£40,661	£88,742	696,000	5.35		4.64
Kennecott	Alaska	1916	469,970	27,661,713	.....	.....	58.43		11.76
Kinta Tin Mine	Malay	'15-'16	915,000 (c)	£22,421	£19,800	.....	.....		100.095
Knights Central	Tran.	1916	321,575	£23,205 (g)	.....	296,800	5.08		4.74 (g)
Knights Deep	Tran.	'15-'16	1,307,300	£197,942 (g)	£111,528	2,614,000	3.69		2.96 (g)
Kyshtim Corp	Siberia	1915	361,750	.....	.....	2,535,000	.....		.....

Note—Abbreviations used in table: Aus., Australia; B. C., British Columbia; B. Is., British Isles (Cornwall); Hond., Honduras; Malay, Federated Malay States; N. Z., New Zealand; Ont., Ontario, Canada; Rhod., Rhodesia; S. Af., South Africa; S.W. Af., Southwest Africa; Tas., Tasmania; Tran., Transvaal; W. Af., West Africa.

(a) First half. (b) Second half. (c) Cubic yards. (d) Dump. (e) Pesos. (f) Loss for the year. (g) Working profit or cost. All profits and dividends are in dollars, except where otherwise noted.

* Mining engineer, Brady Bldg., San Antonio, Texas.

DATA OF THE WORLD'S PRINCIPAL MINES—(Continued)

Name	Situation	Year	Tons	Profit	Dividends	Reserves, Tons	Price Yield, per Ton	Cost per Ton
Lahat Mines	Malay	1916	242,461 (c)	£17,339	£6,000	.....	$0.95	$0.60
Langlaagte Est	Trans.	1916	595,507	£148,898 (g)	£44,325	1,315,813	5.71	4.43 (g)
La Salle	U. S.	1916	144,829	78,856	.....	.....	2.54	2.00
Le Roi No. 2	Canada	'15–'16	18,958	£13,616 (g)	£6,000	.....	10.79	7.20
Lonely Reef	Rhod.	1916	59,240	£40,099	£42,006	145,309	14.40	11.11
Luipaards Vlei Est	Trans.	'15–'16	256,005	£39,117	£23,600	826,138	5.35	4.62
Magma	U. S.	1916	93,808	1,097,333	480,000	125,000	22.23	9.75
Main Reef West	Tran.	'15–'16	307,680	£42,661 (g)	.....	386,960	5.37	4.70 (g)
Mason & Barry	Spain	1916	193,127	£99,166	£83,327	.....	.....	.....
Mass Copper	U. S.	1916	287,900	525,084	.....	.....	4.34	2.54
McIntyre Porcupine	Canada	'16–'17	195,307	.....	.....	443,617	.....	4.78
McKinley-Darragh-Savage	Canada	1916	62,676	282,304	269,723	.....	9.50	5.00
Messina Dev. Co	Tran.	'15–'16	111,999	£268,725 (g)	£36,357	151,409	.....	.....
Mexico Mines of El Oro	Mex.	'15–'16	.....	.....	.....	503,300	.....	.....
Meter & Charleton	Tran.	1916	176,424	£283,966 (g)	£200,000	512,787	12.05	4.64
Miami Copper	U. S.	1916	1,842,017	7,759,784	4,295,905	16,400,000	7.09	2.33
Moctezuma Copper	Mex.	1916	715,070	.....	.....	.....	.....	.....
Modderfontein Deep Levels	Tran.	1916	453,900	£486,963 (g)	£337,500	3,320,000	9.17	4.07
Mohawk	U. S.	1916	664,547	2,270,054	.....	.....	5.26	1.84
Mother Lode	U. S.	1916	.....	.....	.....	114,328	.....	.....
Mount Boppy	Aus.	1916	72,420	£17,313 (f)	.....	254,000	5.76	6.75
Mount Lyell	Tas.	(a) 1916	166,497	£242,962	.....	2,809,656	.....	.....
Mysore	India	1916	305,845	£266,642	£289,750	1,000,000	13.30	9.09
Namaqua Copper	S. Af.	1916	20,024	£64,960	£47,165	51,264	6.05	4.47
Nevada Con. Copper	U. S.	1916	3,922,634	15,435,359	.....	67,993,117	5.85	2.35
Nevada Wonder	U. S.	1916	72,241	282,528	211,251	.....	14.27	8.90
New Goch	Tran.	1916	365,000	£112,863 (g)	£55,000	404,185	4.55	3.30
New Heriot	Tran.	1916	160,400	£101,526 (g)	£86,256	477,767	8.53	5.45
New Kleinfontein	Tran.	1916	730,820	£202,938 (g)	£57,577	2,943,994	6.08	4.57
Nipissing	Canada	1916	78,120	1,800,000	.....	.....	38.76	.....
North Anantapur	India	'15–'16	32,390	£10,233 (g)	£7,531	44,000	8.44	6.91
North Butte	U. S.	1916	544,454	2,479,595	1,075,000	.....	10.48	7.01
North Star	U. S.	1916	111,330	352,294	300,000	.....	10.42	6.26 (g)
Nundydroog	India	1916	98,000	£105,731	£99,050	217,300	16.90	11.65
Old Dominion	U. S.	1916	358,222	4,723,672	.....	.....	3.91	1.78
Ooregum	India	1916	155,317	£124,439	£120,231	420,821	12.02	8.13
Oroville Dredge	U. S.	1916	164,138 (c)	180,029	436,210	.....	0.0765	0.019
Oroya-Links	Aus.	1916	56,910	7,590 (f)	.....	158,380	5.91	.....
Osceola	U. S.	1916	1,284,681	2,776,160	1,826,850	.....	.....	1.79
Ouro Preto	Brazil	1916	87,600	.....	£1,221	72,316	6.68	6.67
Pahang Consolidated	Malay	'15–'16	162,200	£98,924	£68,155	46,805	.....	.....
Phelps-Dodge	U. S.	1916	2,393,976	24,030,904	14,625,000	.....	.....	.....
Pigg's Peak Dev	Tran.	'15–'16	28,590 (f)	£12,685	.....	18,261	4.48	6.64
Pittsburg-Dolores	U. S.	'15–'16	27,269	.....	.....	.....	7.61	7.67
Plymouth Con	U. S.	1916	125,000	£45,361	£36,000	.....	5.45	3.68
Pittsburgh-Idaho	U. S.	1916	.....	159,934	44,928	.....	.....	.....
Poderosa	Chile	1916	8,923	£67,698	£50,000	.....	63.34	26.47
Portland	U. S.	1916	418,937	.....	420,000	.....	.....	.....
Progress	N. Z.	1916	26,780	£10,413 (f)	.....	80,000	5.38	7.24
Quincy	U. S.	1916	1,204,026	2,758,659	1,980,000	.....	4.46	2.21
Randfontein Central	Tran.	1916	2,209,622	£402,570 (g)	.....	4,944,302	6.24	4.39 (g)
Ray Consolidated	U. S.	1916	3,363,466	12,084,166	4,337,955	93,373,226	5.96	2.29
Rezende	Rhod.	1916	103,443	£9,371 (f)	.....	350,867	3.94	4.39
Robinson Deep	Tran.	'15–'16	965,400	£436,705	£300,000	1,814,000	6.94	4.76
Roodepoort United	Tran.	1916	412,845	£43,271	.....	677,273	4.83	4.63
Rose Deep	Tran.	1916	782,780	£222,921 (g)	£183,750	3,267,280	5.57	4.19
Round Mountain	U. S.	1916	67,452	22,032	.....	.....	5.29	5.06
Santa Gertrudis	Mex.	'15–'16	227,616	.....	360,000	1,214,000	.....	.....
San Miguel Copper Mines	.....	1915	26,834	£1,835 (f)	.....	.....	.....	.....
Seoul Mining	Chosen	1916	176,518	918,502	250,000	474,500	10.33	.....
Shannon Copper	U. S.	1916	256,050	821,054	.....	.....	9.97	6.76
Shattuck-Arizona	U. S.	1916	183,968	3,074,012	.....	.....	22.88	9.61
Sheba Gold	Tran.	'15–'16	83,125	£11,610	.....	40,500	6.85	6.16
Silver King Consolidated	U. S.	1916	10,062	.....	294,562	.....	.....	.....
Simmer & Jack Proprietary	Tran.	'15–'16	797,900	£303,792 (g)	£262,500	1,935,000	5.35	3.50
Sissert	Russia	'15–'16	.....	Rs. 10,744	.....	4,070,000	.....	.....
Simmer Deep	Tran.	1916	761,420	£56,465	.....	1,246,000	4.33	3.99
South Crofty	B. Is.	1916	71,706	£16,703	£16,250	.....	6.98	5.84
South Hecla	U. S.	1916	9,059	.....	.....	.....	.....	.....
South Kalgurli	Aus.	'16–'17	110,333	£4,050	£3,125	133,221	5.53	5.35
St. John del Rey	Brazil	'16–'17	187,400	£155,593	£64,626	.....	12.21	8.19
Sub-Nigel	Tran.	'15–'16	91,130	£32,759 (g)	£32,368	214,000	9.64	7.90 (g)
Sudan Goldfields	S. Af.	1916	26,297	£15,194	£6,538	60,193	10.08	7.08
Sulphide Corporation	Aus.	'15–'16	184,470	£771,308	£315,000	1,858,200	.....	.....
Superior Copper	U. S.	1916	185,315	331,933	100,000	.....	4.18	2.40
Tanalyk Corp	Malay	1915	33,445	.....	.....	201,200	.....	.....
Taquah Mining and Exploration	W. Af.	'15–'16	68,012	£64,425	£77,495	209,299	14.44	9.85
Tekka	Malay	1916	496,040 (c)	£37,608	£30,000	.....	0.48	0.11
Temiskaming	Canada	1916	.....	225,000	.....	.....	.....	.....
Tennessee Copper	U. S.	1916	385,188	387,657	.....	.....	.....	3.50
Tharsis Sulphur	Spain	1916	416,084	£199,149	£187,500	.....	.....	.....
Tincroft	B. Is.	(b) 1916	29,095	£1,190	.....	.....	6.29	6.45
Tincroft	B. Is.	(a) 1917	27,374	£3,565	.....	.....	7.49	6.90
Tom Reed	U. S.	1916	46,000	131,000	.....	54,000	11.03	6.48
Tonopah Harbour	Malay	'15–'16	3,363,750 (c)	£40,808	£60,000	.....	0.16	0.09
Tonopah Belmont	U. S.	'16–'17	145,024	1,245,100	750,018	.....	16.31	7.67
Tonopah Mining	U. S.	1916	87,324	.....	150,000	72,100	14.31	8.71
Tough-Oakes	Canada	1916	39,863	260,668	265,750	.....	.....	.....
United Copper	U. S.	1916	.....	123,706	.....	.....	.....	.....
United States S. R. & M. Co	U. S.	1916	.....	8,898,464	1,492,239	.....	.....	.....
United Verde Extension	U. S.	1916	80,159	6,938,100	1,050,000	1,000,000	124.10	37.96
Utah Consolidated	U. S.	1916	360,034	1,924,176	1,125,000	203,400	.....	.....
Utah Copper	U. S.	1916	11,012,026	33,747,740	19,493,880	369,845,558	4.45	1.90
Van Ryn Deep	Tran.	1916	530,070	£575,315 (g)	£478,756	2,168,851	9.58	4.31 (g)
Victoria	U. S.	1916	.....	85,330	.....	.....	.....	.....
Village Deep	Tran.	1916	626,900	£266,713	£198,875	2,378,000	7.17	5.10
Village Main Reef	Tran.	1916	333,885	£161,638	£118,000	750,204	6.98	4.64
Vindicator	U. S.	1916	180,282	564,813 (g)	270,000	412,798	.....	.....
Waihi Grand Jc	N. Z.	1916	125,780	£49,796	£38,439	157,700	8.60	6.65
Wallaroo & Moonta	Aus.	1916	67,507	£231,504	£140,000	.....	.....	.....
Wanderer	Tran.	'16–'17	164,700	£17,349	£30,000	60,000	2.08	1.59
West Rand Consolidated	Tran.	1916	402,590	.....	.....	1,600,000	5.79	4.76 (g)
Winona	U. S.	1916	161,829	106,720	.....	.....	3.75	.....
Witwatersrand Gold	Tran.	1916	515,000	£258,618 (g)	£234,812	1,462,100	6.16	3.73 (g)
Wolhuter	Tran.	'15–'16	424,500	£161,223 (g)	£129,000	1,302,160	6.10	4.25
Yellow Pine Mining	U. S.	1916	22,662	66,252	.....	.....	43.52	9.92
Zinc Corporation	Aus.	1916	136,901	£212,477	£206,433	1,710,631	.....	.....

Antimony in 1917

By K. C. LI*

ANTIMONY did not present in 1917 the same interesting and sensational movements as were revealed in 1916. Indeed, were it not for the fact that consumption of antimony was much above the normal and prices remained 100% above the normal prewar level, 1917 might almost be regarded as a normal year. By this I mean that fluctuation in prices during most of 1917 was little greater than would naturally occur in any ordinary year.

At the beginning of 1917 antimony was only starting to recover from the debacle into which it had been thrown in the autumn of 1916 by the unloading of large stocks at very low prices. As the year progressed, spot prices slowly advanced, until on Mar. 29 the maximum of about 36c. per lb. was reached. Spot then steadily declined, until on Nov. 13 a minimum of about 13¾c. was touched. Curiously enough, the price for future shipments did not increase to an extent corresponding to the rise of spot prices. It would seem, therefore, that the short-lived boom in spot was due to the fact that production and imports fell off toward the end of 1916, thus creating in the early weeks of 1917 a scarcity of spot.

The situation in Russia was a factor that tended to prevent long continuance of high prices. It is a well-known fact that more shrapnel was used on the Russian front than on any other front of the war, and a large proportion of Russia's supplies was manufactured in Canada and shipped through England. With the collapse of Russia as a fighting force, the demand for antimony was greatly reduced. Now antimony importers are waiting patiently to see whether the entrance of America into the war will not more than counteract the effect of Russia's collapse. Up to the present any orders placed by the Government of the United States have not affected the antimony market to a great extent. At the end of December the market was a little stronger than it had been for several months, but it remains to be seen whether the speeding up of war preparations by America will lead to a boom such as characterized the antimony trade during the winter of 1915-16.

AVERAGE PRICES OF ANTIMONY (a)

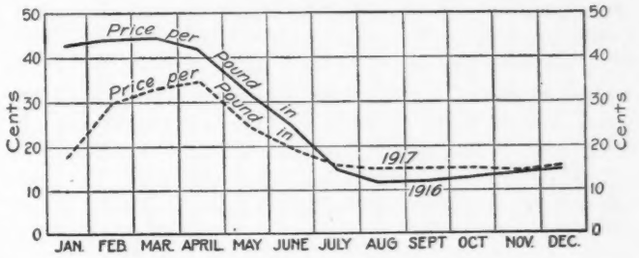
(In Cents per Pound)

	1914 Ordinaries	1915 Ordinaries	1916 Ordinaries	1917 Ordinaries
January	6.125	15.85	42.45	17.29
February	6.100	18.21	44.31	29.80
March	6.053	22.13	44.75	32.89
April	6.006	24.88	42.06	34.04
May	5.845	35.30	31.60	25.20
June	5.825	37.69	20.05	19.51
July	5.638	38.13	14.70	15.83
August	13.800	33.00	11.53	15.06
September	9.940	28.63	11.81	14.94
October	12.060	31.45	12.70	14.75
November	14.450	38.88	13.84	13.91
December	13.310	39.25	14.59	15.06
Year	8.763	30.28	25.37	20.69

(a) Engineering and Mining Journal quotations.

For the greater part of 1917 antimony sold at a price little if anything above the cost of production. This was another feature I had in mind when stating that 1917 might almost be regarded as a normal year. The price of any commodity in normal times tends to remain fixed at a point just a little above the cost of production. This is perhaps the chief factor that has prevented antimony from going any lower than 13 or 14c. In China, for example, the cost of production has been almost doubled owing to the great rise in the price of silver and high prices of fuel. The Chinese laborer is paid in silver, and when the price of silver is doubled it practically amounts to doubling the cost of production of any commodity produced in China.

It is not possible to say much regarding either domestic production or imports for 1917. The comparative dullness in the trade seems to have resulted in less interest being manifested in developing further domestic production than was the case in 1916. In any event, I did not succeed in collecting much information regarding domestic production for the year. The Western Metals Co., with a smeltery in Los Angeles, is still actively engaged in the production of antimony, but little has been heard of other domestic producers. Conditions are now against the home producer, and on that account there is probably little activity in the mining of antimony in the United States.



GRAPH SHOWING THE COURSE OF ANTIMONY PRICES IN 1916 AND 1917

Information regarding imports of antimony and antimony ore is not readily obtained since the Bureau of Foreign and Domestic Commerce discontinued its highly useful monthly statement of imports of those products. In the absence of these statements, it would be a laborious task to collect information from the different ports of entry, and there is not sufficient time available to complete such data. The Wah Chang Co. imported in 1917 a smaller proportion of the total imports than in 1916. For the 10 months ended in October about 12,500 tons of antimony were imported; a large proportion of this came in as antimony ore and was smelted in this country. Indeed, during nine months of 1917 nearly 2000 tons more ore were imported than was the case for the corresponding period in 1916. This would seem to indicate that smelting of antimony in the United States was much greater in 1917 than in the previous year.

It may fairly be assumed, however, that the actual imports of refined metal were less for 1917 than for 1916, one reason being that less antimony was exported from the United States to Canada. In 1916 Canada

*Mining engineer and metallurgist, 4904 Woolworth Building; representative in New York of the Wah Chang Mining and Smelting Co., Ltd., of Changsha, China.

used a large quantity of antimony, but there has been no demand from Canada for some time. Indeed, during the last few months antimony bought by Canadian munition makers for their own requirements was found to be unnecessary, and some of it crossed into the United States.

Having embarked upon a war program, some increase in the consumption of antimony in the United States may be expected during the coming months, with a consequent recrudescence of activity in the industry. Prices paid for antimony at the close of 1917 were not encouraging to the Chinese producers, who must transport the metal 12,000 miles, and the result is that foreign production is falling off. It is essential that America be assured of an adequate supply of antimony to cover her war requirements, and I venture to state that such a supply can be secured only by paying better prices. The methods of purchase adopted by the United States Government will probably tend to prevent quotations from soaring as they have done in the past, but with the larger volume of trade and prices a little better than at the end of 1917, the future of antimony would appear cheerful, and producers feel that a revival in antimony is about due.

The Tungsten Industry

BY FREDERICK W. FOOTE*

A PRELIMINARY estimate for 1917 shows an indicated U. S. production of 6000 tons of tungsten concentrates, as against 5200 in 1916. Imports from Bolivia (via Chile), Peru, Argentina and Portugal to the amount of about 4000 tons were noted and 1600 tons were exported, indicating a consumption in the United States of 8400 tons of concentrates per year. The steadiness in price in 1917 and the attendant sense of security lent to the industry caused its establishment on a firmer basis and made it less of a "war baby," as post-war use of tungsten on a large scale now seems assured.

California the Leading U. S. Producer

California in 1917 made the largest production, followed closely by Colorado, with Nevada and Arizona about even for third place and small productions reported from South Dakota, Idaho, Utah and Missouri. In California the Atolia Mining Co. continued to be the chief producer, while the deposits near Bishop, Inyo County, gave evidence of soon adding materially to the California output. As before, practically the entire production of Colorado was derived from the ferberite deposits of Boulder County and the northern part of Gilpin County. In this district the milling of tungsten ores not containing metallic impurities has probably reached the highest stage of development attained anywhere in the world. The Vasco Mining Co., the Primos Chemical Co., the Wolf Tongue Mining Co., the Boulder Tungsten Production Co. and the Rare Metals Ore Co. were the chief operators in the district. Several new mills were built during the year and all operators continued to alter their plants to keep abreast of modern practice. Refining works have been built within the last two years in the Boulder District.

Nevada suffered during 1917 from unsatisfactory ore developments and treatment methods, so that little if any increase in production is to be expected.

Detailed information relative to Arizona is lacking. South Dakota production was reduced because of the irregular operation at the Wasp No. 2—the leading producer, after the Homestake company. In Missouri the Einstein mine, which is 12 miles west of Fredericktown, was in operation and produced about 50 tons of concentrates; it is now shut down and the mill is being remodeled to conform to present metallurgical practice. The property near Trumbull, Conn., was inactive, as the mill burned down and was not rebuilt.

Summing up, the tungsten industry in the United States has the following characteristics: The persistency of the scheelite deposits of California and of the ferberite deposits of Colorado has been demonstrated and they constitute the backbone of the tungsten industry in the United States. Other deposits of commercial grade have been developed and brought up to a production of considerable importance. The metallurgy at Atolia and Boulder is good, but at many of the small operations in other districts it is poor and inefficient, due to a lack of knowledge of tungsten metallurgy and the absence of experienced technical direction or advice.

Tungsten in Foreign Countries

In a review of tungsten activities in foreign countries, several important developments are worthy of note. In the southern part of China, in Kwantung and Hunan Provinces, the natives discovered and began work on alluvium deposits, and a production of as high as 100 tons of concentrates per month was reported from these small operations. The work was done entirely by hand and the product was transported on men's backs and small river junks until it finally reached Canton and was shipped out via Hong Kong. Export permission for shipping to the United States was cut off in August by the British restrictions in Hong Kong. This Chinese field should be an interesting one for systematic exploration and development when proper export facilities have been arranged, and might prove capable of augmenting the present world's production to no small degree. Another country in which tungsten production was obtained in 1917 was Rhodesia. Preliminary work on the wolframite alluvium disclosed the presence of the quartz veins from which the alluvium was derived. By means of hand concentration the coarse alluvium was treated and small shipments were made.

Perhaps one of the most strikingly significant features was the doubling of production in Bolivia and Peru, due to the competitive activities of English and French ore-buying commissions. Imports into the United States from South America were about the same as in 1916, so that the excess production was shipped to Eng-

*Mining engineer, care of Moore & Schley, 80 Broadway, New York.

land and France to augment the supply from Burma, French Indo-China and Siam, which was about the same as in 1916. Higher war-risk insurance in the Mediterranean than in the Atlantic may be an explanation for this pushing of South American production instead of that of the East.

In Australia, the working of various placer scheelite deposits has been noted from time to time, and in 1917 at least one property developed sufficient lode tonnage to warrant the construction of a concentrating mill. The King Island Scheelite Co., a subsidiary of Broken Hill Block 14 Co., was formed to operate this mine and plant, which has a present capacity of 150 tons of 60% concentrates per year. Work was also done in Australia by the Thermo Electric Ore Reduction Corporation on the metallurgical problem in the separation of complex scheelite ores, so that Australia should not be counted a waning producer, as development there is making fair progress.

In Europe the chief producing country continues to be Portugal. The situation there is somewhat similar to that in Bolivia and Peru, with the addition of strong American interests. The English and French companies at Panasqueira and Borralha are forcing production, while the newly started American interests have acquired a firm hold in the Viseu district, after suffering initial discouragements due to difficulties in securing and maintaining export permission. Portugal is an extremely important source of tungsten for the Allies, being so near the seat of need and subject to the minimum of war shipping risk of all foreign imports for England or France.

Dressing of Tungsten Ores

The American practice of tungsten concentration is becoming more and more standardized as the character and peculiarities of the ores are better understood. The use of stamps for the secondary crushing has practically become obsolete and they are being replaced by two or three sets of rolls arranged to give successive reduction in stages rather than a shattering such as is produced by the use of stamps. This throws a heavier duty on the jigging department, so that the tendency in the new mills is to have greater jigging capacity and less table capacity. This tends toward compactness and causes the recovery of the tungsten in larger form than formerly and reduces the losses by slime. Tungsten slime is difficult of recovery, but it seems to be accomplished fairly well by means of thickening cones, slime tables and canvas or "rag" plants. This slime product is of lower grade than the coarser products, but is suitable for electric-furnace treatment. It is a characteristic of tungsten concentrates to be lower in grade the more finely they are crushed.

The practice of hand sorting the high-grade ore from the mines is a good one, but this ore should be stored, and when sufficient quantity has been obtained should be sized and introduced into the mill at its proper point so that it may be mechanically cleaned and its grade raised. At present in the Boulder district extractions as high as 92% are obtained, so that the cleaning of the hand-sorted ore would be justified, as the grade could be raised to over 70% and thus claim a premium over the present practice at some mills of shipping 55% hand-sorted ore.

For the most part, the American tungsten ores are free from the metallic constituents found as a rule with the foreign ores, so that the concentration problem is more easily handled than it would be if commercial separation of tin, lead, zinc and iron had to be accomplished. These problems have presented themselves to the engineers operating in South America and Europe, and proper methods have been worked out that promise satisfactory results.

Tungsten Ore Market

By Charles Hardy*

The year 1916 closed with the business in tungsten comparatively dull, and prices had just recovered to a price level of $17 per unit, after having been up to $90 per unit during the run of 1916. During the first week of 1917 considerable arrivals from South America prevented a steady and strong market from immediately advancing. Arrivals during January exceeded 600 tons, which was a larger quantity than had been received in the United States during any previous month, and naturally such an accumulation prevented an advance in prices. However, on the very first business day France appeared as a buyer in our market, taking a considerable quantity, which made it possible readily to absorb a fair share of the surplus arrivals, thus exercising a stabilizing influence upon the market and preventing any tendency towards serious breaking.

AVERAGE MONTHLY PRICE OF TUNGSTEN ORE (a)

(In Dollars per Unit, WO_3)

	1917			1917	
	Wolframite	Scheelite		Wolframite	Scheelite
January	17.14	17.50	August	24.66	26.50
February	16.80	17.50	September	23.92	26.00
March	17 17	17 77	October	24 00	26.00
April	17.86	19 04	November	26.00	26.00
May	19 10	20 94	December	25.24	26.56
June	20 80	23 50			
July	23.44	25.68	Year	$21.34	$22.75

(a) Engineering and Mining Journal Quotations

During January, however, quotations remained at the same level of $17, which figure continued into the first half of February. Winter conditions in the West then interfered with the California and Colorado production and shipments to the East, and buyers who had not provided themselves with stock, on account of the uncertain future of the tungsten market, found themselves without supplies, and bought from New York stocks for express shipment. The price advanced to approximately $18 during February, and in March, when Italy appeared in our market as a heavy buyer of ferrotungsten and tungsten powder, the market took a strong turn. New York stocks were readily absorbed and contracts were concluded to cover Western tungsten ore for delivery over the greater part of 1917. In the third week of April purchases made against contracts for several of the foreign governments interested in buying amounted to close to 1000 tons, and prices took an upward turn.

Western shippers decided to fix by the first of May their lowest quotation at $20 a unit, and naturally the New York market followed suit, and before the month was a week old business was done in large quantities at $20, though foreign ore could still be had below that figure. The foreign ore has always to be sold at a

*50 Church St., New York.

discount, as, coming mostly from Bolivia, Peru or Japan, it contains impurities such as tin and copper, which are rarely found in domestic tungsten ore. New York stocks were so much depleted by the end of May that it was impossible to make up any carload lot in a uniform quality and the ore had to be bought from many different importers in five- and 10-ton lots.

Early in June the spot position became serious; the Western producers were sold out for early delivery and unwilling to contract for future supplies. South American ore of good quality was fully sold and any wolframite that could be secured readily obtained a premium over the Western schedule price of $20, which was now only a basis for contracts to be completed, as no new ore could be bought on this basis. Such conditions, of course, worked for a rise, and this rise took effect during the first days of July, when deliveries right to the end of 1917 were contracted for at $25 per unit by the Western producers.

During the latter half of 1917 prices hardly changed from those current in July. The main producers had contracted for everything that could be had between July and the end of the year at $25@26, and they were unwilling to make contracts into 1918. The foreign ore followed closely the price lead set by the Western producers, and while at times arrivals from South America were heavy, the demand continued steady, and freight congestions on the one hand or license difficulties on the other served as a kind of price regulator and steadied the market the last half year.

The average monthly consumption for 1917 in the United States amounted to about 800 tons. Importation averaged about 300 tons monthly, leaving for home production approximately 500 tons, which was readily absorbed. The year closed with wolframite quoted at $25. Scheelite, spot delivery, sold at $26, but no forward delivery from Western producers was to be had below $30. At this latter figure business was done for delivery well into 1918, and with present conditions in the tungsten market the Western producers expect to maintain this figure for all of their production.

Arsenic in 1917

Prices in the United States reached the high point of 16½ @ 17c. per lb. for white arsenic in 1917, with a heavy demand for export. In the latter part of the year, exports were curtailed and the price dropped to 15½c. per lb., although higher prices were asked abroad and imports were cut off.

No new processes were developed, although it was reported that a larger production could be secured by byproduct treatments, and through the starting of some arsenic mines formerly operated, notably the Brinton mine, in Virginia. A greater saving was urged by the Food Administration, which assumed charge of the industry on Nov. 15. About one-third of the arsenic production in the United States was consumed in the glass-making industry as a substitute for antimony oxide, the price of which had increased. The manufacture of poison gases created a further demand.

Imports of arsenic for nine months ended Sept. 30, 1917, were valued at $226,190, having amounted to 3,525,816 pounds.

Molybdenum

BY CHARLES HARDY*

The consumption of molybdenum in the United States, and in fact in the world, is much smaller than is generally supposed. Molybdenum has been so much in the forefront of discussion that people assume that molybdenum is available in large quantities. However, it is a fact that the total production of molybdenum-carrying ores in 1915, the last year for which figures are available, amounted to a total of only 222.6 tons of molybdenum. Of this the United States produced 91 tons, followed by Australia, in which Queensland produced 58.8 tons, and New South Wales about 19 tons. Norway came next with about 40 tons. The remainder was produced in small quantities, mainly by Canada, Spain and Peru. In 1916 and 1917, however, a considerable increase in the molybdenum production occurred, and while no exact figures are available, I believe that it would not be a wrong estimate to assume that the world's production rate practically doubled during the last two years. Methods of concentration were improved and molybdenite ore running as low as 1% was successfully treated.

The users of molybdenum were considerably added to on account of the war and the principal buyers are

AVERAGE MONTHLY PRICES OF MOLYBDENITE (*a*)

(In Dollars per Pound in Concentrates Assaying 90%)

	1917		1917
January	1.81	July	2.16
February	1.80	August	2.14
March	1.90	September	2.18
April	2.10	October	2.20
May	2.95	November	2.20
June	2.15	December	2.27
Year			2.16

(*a*) Engineering and Mining Journal Quotations

the European governments, which found molybdenum, or rather ferromolybdenum, an excellent addition to steel for the making of trench helmets, gun linings, armor-piercing projectiles, and in the form of molybdenum trioxide as an addition to mellinite powder. Molybdenum ores either in the form of molybdenite or wulfenite are found in many places in the United States, but the ore is generally so finely disseminated that operations at present are carried on in a comparatively small way. Should, however, the United States Government require molybdenum in quantities, the United States Geological Survey is under the impression that under the supervision of Government agents all the molybdenum ore necessary could be obtained within this country.

The molybdenum price rose from $1.75 for 90% concentrates at the beginning of 1917 to $2.25 at the end of the year. These high prices helped considerably to stimulate the production, and during the last two months a little more molybdenite was offered, allowing the makers of ferromolybdenum to contract more freely for this product. At the beginning of 1917, few ferromolybdenum makers were prepared to enter into any contracts unless they had the molybdenum ore required for such contract actually at their works, as little reliance could be placed upon getting ore regularly from the producers. With the world's requirements for molybdenum on the increase, the present prices should be maintained in the near future even in the face of an appreciable increase in production.

*50 Church St., New York.

Metallurgy of Lead

By H. O. HOFMAN*

LEAD metallurgists noted with sorrow that there passed away in 1917 the last of the three American pioneer lead smelters. Anton Eilers died Apr. 21, 1917, Otto H. Hahn and August Raht preceded him only a short time, the former having passed away on July 26, 1915, and the latter on Dec. 26, 1916. These men laid the foundation of modern lead smelting, which is, that the operations of the blast furnace have to be controlled strictly by the chemical laboratory. The work of their successors was to define more clearly than was possible at the start the limits of the various chemical reactions. With the increase in size of plant and, accompanying this, the decrease in the number of competitive smelteries, the aim of operators at present is to handle materials by machinery instead of by manual labor, as used to be the case with smaller plants. In addition, minor details are now looked after carefully so as to leave no loose ends and to change into marketable products materials which formerly went to waste.

The increased price of lead and silver in 1917 brought to smelteries an increased supply of silver-lead ores. Refineries received additional amounts of lead bullion owing to the starting of some of the silver-lead mines and smelteries in Mexico. Thus in 1917 the works of the country had more units in operation than was the case in the preceding year.

Lead Smelting Practice

The smelteries of the lower Mississippi Valley, which furnish about 40% of the country's lead, treated various grades of galena concentrates,[1] ranging from flotation slimes with 50% Pb to different grades of jig and table products with from 60 to 70 and even 80% Pb. Materials with less than 70% Pb were blast roasted and smelted in the blast furnace; those containing 70% Pb and over went to the ore hearth. The Newman ore hearth referred to last year continued to be a success. A typical analysis of undesilverized lead of the Mississippi Valley region shows Ag 0.0080% (2.4 oz. per ton), As trace, Sb 0.0030, Bi trace, Cu 0.0800, Fe 0.0015, Zn trace, Ni and Co 0.0080, Pb 99.8995%. At Herculaneum, Mo., and Collinsville, Ill., the lead is desilverized by means of the Parkes process to recover the silver and to furnish a higher grade of lead; the desilverized lead contains Ag 0.0005% (0.15 oz. per ton), As trace, Sb 0.0020, Bi trace, Cu 0.0002, Zn 0.0004, Pb 99.9665%.

Plants treating silver-lead ores gave considerable attention to mixed zinc-lead ores, the production of electrolytic spelter having become a practical process. The ore is given a sulphatizing roast, leached with H_2SO_4, the solution purified, and the zinc precipitated, using lead anodes, aluminum cathodes and a purified electrolyte of $ZnSO_4$ which is nearly neutral. Some of the difficulties have been overcome; others have not. Thus, while a laboratory test of a sulphatizing roast may show an extraction of over 90% of the zinc, actual work at the plant yields usually about 60%. The Hamilton-Murray-McIntosh[2] experiments with Sullivan ore, Kimberly, B. C., showed that above 630° C. ZnO combined with Fe_2O_3 into an insoluble compound, that free Al_2O_3 had a similar tendency, and that the amount of combination depended mainly on temperature and time. The form of furnace and the mode of operating must be improved before standard working conditions can be obtained. Upon neutralizing the acid zinc solution with ore there was observed a tendency of zinc to fall out of solution, which is unwelcome in the residue and as regards yield. In the purification of the electrolyte there is also much room for improvement.

The smelting division at the works of the Bunker Hill & Sullivan Mining and Concentrating Co., at Kellogg, Idaho, went into blast July 5, 1917. It has one Wedge roasting kiln, three Dwight-Lloyd sintering machines, and three water-jacket blast furnaces, 48 x 180 in. at the tuyeres. A blast furnace at this plant treats in 24 hours from 250 to 285 tons charge containing from 36 to 40% lead.

Experiments in Hydrometallurgy of Lead

New methods of treatment of lead ores, be they dry or wet, usually do not get beyond the experimental stage, but two recent modes of procedure studied in the laboratory[3] of the Bureau of Mines at Salt Lake City may form an exception to the general rule. One method gives low-grade oxide lead ore a chloridizing roast in a reverberatory or blast-roasting furnace at a temperature of 850°-900° C. with the aim of volatilizing the chlorides of lead, gold and silver formed, which are collected in a dust chamber supplemented by a Cottrell electrostatic precipitator. The extractions obtained on a small scale reached 99% of the lead and from 80-90% of the gold and silver. With sulphide ore the lead is readily volatilized, but not the precious metal; this remains behind and has to be recovered by lixiviation. The other method involves the lixiviation of raw oxide lead ore with saturated brine, acidified with sulphuric acid, and the recovery of this lead either by electrolysis or by precipitation with burnt lime. Extractions of lead varied from 80-98%, depending upon the amounts of lead present as sulphide.

Experiments[4] at Kellogg, Idaho, with sulphide lead ore, involving chloridizing in a Holt-Dern blast roaster and leaching with acidulated brine, gave a yield of lead of 85-95% and of silver of 80-90 per cent.

Automatic Bag Filter for Furnace Gases

Most smelteries conduct the gases issuing from blast furnaces through baghouses in order to save the volatilized metals and to serve as a protection against lawsuits arising from the damages that dust and fume may inflict upon the surrounding country. It is at present accepted[5] that a filtering surface of 3.45 sq.ft. per cu.ft. of gas per minute is needed for this purpose. The au-

---

*Professor of metallurgy, Massachusetts Institute of Technology and Harvard University, Cambridge, Mass.

[1]Garlichs, "Bull.," A. I. M. E., July, 1917.

[2]"Bull.," Can. Min. Inst., July, 1917, p. 615.

[3]Ralston-Williams-Udy-Holt, "Bull.," A. I. M. E., August, 1917.

[4]Larson, "Min. and Sci. Press," 1917, Vol. 115, p. 275.

[5]Eilers, "Trans.," A. I. M. E., 1912, Vol. 44, p. 720.

tomatic bag filter[6] at Depue, Ill., reduced this figure to 0.50 sq.ft. The essential features are that the bags of a division are alternately inflated from a pressure pipe connected with the blast-furnace flue, and collapsed from a suction pipe, and that while under suction the bags are shaken mechanically, receiving an up-and-down as well as an undulating motion. The combination of suction and shaking was found to be especially effective in cleaning the cloth and thereby increasing the filtering capacity.

While the solids carried by smelter gases are readily removed either by filtering or by electric precipitation, the purified gases carry sulphurous and sulphuric acids in amounts which are harmful to vegetation. The whole subject was carefully studied by the U. S. Bureau of Mines, and the accepted ideas of the harmful effects of sulphurous gas will have to be somewhat modified. There remains the possible recovery of sulphur, and one phase of this question was studied[7] by the Bureau.

With the advent of the war the cost of labor, fuels and materials was greatly increased and with them the cost of treatment. H. H. Alexander, manager of the Perth Amboy, N. J., plant of the American Smelting and Refining Co., states[8] that the available labor supply had decreased 20%, that the cost of it had risen from 20-50%, and that at the same time the efficiency had fallen off from 25-30%. As regards materials required in the smelting and refining, he found the following percentage increases in cost: Firebrick, 50%; common brick, 30; magnesite brick, 300; iron, 45; steel, 80; castings, 45; crucibles, 135; retorts, 265; nitric acid, 35; sulphuric acid, 30; and zinc, 170 per cent.

[6]Brooks-Duncan, "Bull.," A. I. M. E., November, 1917.
[7]Wells, "Bull. 133," U. S. Bureau of Mines, Washington, D. C., 1917.
[8]"Eng. and Min. Journ.," 1917, Vol. 103, p. 219.

Refining Practice Unchanged

There was practically no change in the practice of desilverizing lead bullion. The Parkes process prevails in all plants except in the works of the United States Metals Refining Co. at East Chicago, Ind., which uses the Betts process. In Canada this process was also used by the Consolidated Mining and Smelting Co., in its works at Trail, B. C. The works at Omaha, Neb., treats but a small amount of lead bullion rich in bismuth by the Betts process, in comparison with the total output of the plant. The Balbach Smelting and Refining Co. had in full operation its new refinery, and is contemplating a considerable increase in capacity.

Attention may be called to the valuable description[9] by W. E. Newnam of the Tredinnick process, as formerly carried out at Omaha, Neb., for concentrating bismuth in a small amount of lead by fractional crystallization on the Pattinson principle. Of special interest was the change that the original process had to undergo to be suited to modern conditions.

[9]"Bull.," A. I. M. E., May, 1917.

Metallurgy of Copper

By Arthur L. Walker*

THE extraordinary activity in the copper industry and the enormous increase in production which began in 1915 continued through 1916 and well into the first half of 1917. By this time the concentrating, smelting and refining plants had increased their capacity so that the ore from the mine could be treated and the product refined without delay. By the middle of 1917, however, the difficulty of obtaining supplies, high prices, serious strikes which occurred in the West and labor troubles in general began to have a restraining effect on the industry and production for the last six months fell off greatly.

Only One Important New Plant Completed

To what degree these circumstances affected construction is uncertain, but it is known that a number of definite propositions for smelting and refining plants were held up on account of the conditions which obtained. The only plant put in commission in 1917 was that of the New Cornelia Copper Co. in the Ajo district, Arizona.[1] This is a leaching and electrolytic works.

At this plant the ore, which contains about 1.5% copper, is crushed in a No. 24 Gates gyratory breaker and then by stages to ½-in. size. It is leached in lead-lined concrete tanks 15 ft. deep, which was considered the proper leaching column for this ore. There are 12 of these tanks, each having its own pumping unit, which handles the solution containing about 3% free sulphuric acid. The solution is enriched by passing it from tank to tank according to the order of charging, the fresh solution passing through the oldest charge first. After it is enriched to the proper degree it is run to the electrolytic tank house, where there are 158 lead-lined tanks, each 30 ft. long, 4 ft. wide, and 5 ft. deep. In these tanks electrolytic copper is deposited on copper cathodes, insoluble lead anodes being used. The solution from the leaching tanks is fairly pure, but nevertheless contains some dissolved iron and alumina, so that in order to maintain the proper standard some solution must be withdrawn as it passes from the electrolytic tanks and discarded. The remainder of the solution travels back to the leaching tanks, the sulphuric acid having been regenerated in the process of electrolysis. The discarded solution is passed over scrap iron for the purpose of recovering the remaining copper content.

Utah Copper's Leaching Operations Delayed

During the last decade many metallurgists gave a large amount of their time and paid especial attention to the wet treatment of copper ores. Many processes have been brought forth and attempts made to treat different kinds of oxidized ores. Only a few of these operations have been successful but these few demonstrate that wet methods can be successfully carried on for certain ores, and under favorable conditions better recovery can be obtained than by any other method. The work performed at the big leaching plant at

*Professor of metallurgy, Columbia University, New York.
[1]"Eng. and Min. Journ.," Vol. 103, p. 443.

Chuquicamata and in the Ajo district are striking examples of what can be accomplished by the process. The Utah Copper Co. is now installing[3] a plant similar to the ones operating at Chuquicamata and Ajo. This plant is designed to treat the oxidized surface ores of Bingham Canyon, and if it proves successful, as indicated at present, it will undoubtedly be one of the biggest leaching operations. The ore is crushed to ½-in. mesh and then leached in large tanks which have a length of 100 ft., a width of 50 ft. and a depth of 18 ft. After leaching, the solution containing copper runs through a revolving drum charged with scrap iron and in this drum the copper is precipitated. The solution and precipitated copper are then conveyed to Dorr thickeners, where the precipitate is separated. The copper precipitate is then shipped to the smeltery for treatment. The solution overflowing from the Dorr thickeners is passed through a series of launders filled with scrap iron, where the remaining trace of copper is recovered. The original plant was designed for 4000 tons and should have been completed last summer, but owing to delays it will not be put in operation until 1918. An enlargement of this plant is now contemplated; also the substitution of electrolytic precipitation for scrap iron.

ELECTROLYTIC COPPER REFINERIES OF THE UNITED STATES

Name of Company	Situation of Plant	System Used	Tanks — Number	Tanks — Inside Dimensions, In.	1916 Capacity, Pounds	1917 Capacity, Pounds
Balbach Smelting and Refining Co.	Newark, N. J.	Multiple	446	108x28x44	45,000,000 (a)	45,000,000
Nichols Copper Co	Laurel Hill, N. Y.	Series	615	126x66x60	480,000,000 (a)	480,000,000
Raritan Copper Works	Perth Amboy, N. J.	Multiple	3,456	119½x34x44	480,000,000 (a)	480,000,000
Baltimore Copper Smelting and Rolling Co.	Canton, Md.	Multiple	187	137x42x42	444,000,000 (a)	444,000,000
		Series	528	128x26x30(c)		
		Multiple	1,334	161x43x49	144,000,000 (a)	288,000,000
American Smelting and Refining Co.	Maurer, N. J.	Multiple	1,632	132x42x42	300,000,000 (b)	300,000,000
United States Metals Refining Co.	Chrome, N. J.	Multiple	1,228	132x42x42	230,000,000 (b)	250,000,000
Anaconda Copper Mining Co.	Great Falls, Mont.	Multiple	338	115x28x45	60,000,000 (a)	60,000,000
		Multiple	1,020	123x34x45	192,000,000 (a)	192,000,000
Tacoma Smelting Co.	Tacoma, Wash.	Multiple	460	98x33x44	144,000,000 (b)	204,000,000
			720	148x33x44		
Calumet & Hecla Mining Co.	Hubbell, Mich.	Multiple	512	130x34x48	65,000,000 (a)	65,000,000
					2,584,000,000	2,788,000,000

(a) Official data. (b) Estimated. (c) Six-compartment tanks.

Ammonia Leaching in Michigan and Alaska

The original ammonia-leaching plant of the Calumet & Hecla Mining Co.[4] was so successful that the 2000-ton plant is being doubled. It is expected that this addition will be completed and put in operation before July, 1918. During the first four months of 1917 the total cost of ammonia leaching is given as 4.75c. per lb. of copper and the total cost, including selling and smelting expenses, at about 6c. per lb. The extraction varies with the fineness of the material treated, being greater as the fineness increases. The average extraction was 78% for the four months in question.

At Kennecott, Alaska, the ammonia-leaching plant which commenced operations in 1916 gave such excellent results[5] that a new plant is being designed that will have a capacity of 800 tons a day. This plant will treat the tailings from the concentrating mill, and an extraction of 75% is expected. The cost per pound of copper depends upon the ammonia loss, but was stated to be 17c., which is naturally high on account of the local conditions.

[3] "Eng. and Min. Journ.," Vol. 103, p. 344.
[4] "Eng. and Min. Journ.," Vol. 104, p. 43.
[5] "Eng. and Min. Journ., Vol. 104, p. 781.
[6] "Min. and Sci. Press," Vol. 115, p. 749.

The experiments[6] on heap leaching of sulphide ores at the Copper Queen mines at Bisbee, Ariz., gave excellent results, and it is expected that this method will be used to a certain extent in the future. The practice is similar to that at the Rio Tinto mines. In the first heap, which contained nearly 10,000 tons, an extraction of 25% copper was obtained after working for five months, so it is thought it may take two years to give an extraction of 80% of the original copper. The heap is flooded in the usual manner, and the solution passing from the heap is run into tanks in which the copper is precipitated on iron. The cost of building the heap is 10c. a ton, and the average cost of leaching $10 a day.

Attempts have been made to sulphatize ores with weak sulphurous-acid gases[7] with the idea of utilizing this injurious waste product for the recovery of copper. The ore is placed in large tanks and the gas brought into direct contact in the presence of vapor. The sulphatization is effected by the combined action on the wet ore of the hot sulphurous-acid gas, excess oxygen in the smoke, oxygen with sulphites and water vapor. It has been discovered that the sulphatizing action is satisfactory no matter what the sulphur-dioxide content of the gas. In fact, a range from 0.3 to 5.5% has been found to give satisfactory results. After treating, the ore is leached with water to dissolve out the sulphate of copper and the copper precipitated on scrap iron. It has been found that the recovery ranged from 60 to 90%, but undoubtedly difficulties would be incurred in designing a plant for this work.

Application of Flotation Process Extended

Concentration by flotation is becoming of greater importance, and 1917 witnessed a large increase in the amount of ore treated by this method. Flotation for the treatment of low-grade sulphide copper ores is now used, either exclusively or in part, at all of our large copper concentrating plants, and it is apparently only a question of time when it will entirely supersede table concentration for fine sizes. In addition, material like slime, which it is impossible to treat by table concentration, can be successfully treated by flotation. A loss of at least 20%, and sometimes over 30%, was entailed by the older practice but this has now been reduced one-half. It is stated[8] that the amount of ore worked by flotation at present is largely in excess of the tonnage treated by any other process.

[7] "Eng. and Min. Journ.," Vol. 104, p. 119.
[8] "Journ. Ind. and Eng. Chem.," November, 1917.

Investigations of the smoke question were continued in 1917 in spite of business conditions. The Cottrell process is still found to give the most satisfactory results where it is desired to collect dust particles or sulphur trioxide. Scientific experiments conducted by the American Smelting and Refining Co.[8] demonstrated that sulphur dioxide of a certain degree of concentration is more injurious than either dust particles or sulphur trioxide. This is a remarkable finding and is at variance with certain preconceived ideas. The smelting company's investigations were carried on in such a manner that various crops in different stages were fumigated with sulphur-dioxide gases of varying degrees of concentration. It was found that only gas containing more than the certain degree of concentration was injurious to vegetation, and if the sulphur dioxide tenor of these gases was kept below this point no harm resulted.

As a result of these investigations the smelting company has constructed or is constructing four large chimneys, the aim being to arrange so that the gases will be emitted at as high a temperature as possible and at such a height that the maximum amount of diffusion will result and the SO_2 content be reduced below the danger limit before the gases come in contact with vegetation. At the Murray plant, Utah, a stack is being built which is 450 ft. high and 20 ft. in diameter. At the East Helena plant, in Montana, a stack was recently finished which is 400 ft. high and 16 ft. in diameter. At the El Paso plant, in Texas, a stack 400 ft. high and 30 ft. internal diameter was completed, and at Tacoma, Wash., a stack 571 ft. high and 25 ft. in diameter will be finished in January, 1918. This stack will be the highest in this country.

The only advance in copper-converting operations in 1917 was in the size of the vessels used. The large vertical converters which have been tried out at Great Falls and Anaconda have given such excellent results that they have superseded the smaller converters of this type at these plants. At the Garfield plant, larger Peirce-Smith converters were installed, having diameters of 13 ft., which compares with the original diameter of 10 ft., and with about the same length as the original converters. It is stated that as a result of this increase in diameter the repair of linings has been reduced to about one-quarter of that observed in the smaller-sized vessels. Undoubtedly the reason for this is due in a large measure to the height of the upper surface of the brick lining above the charge, thereby avoiding to a great extent the corrosive action of the metal when blowing.

Electrolytic Refining

The capacity of the electrolytic copper refineries has been enormously increased during the last two years, as shown in a table elsewhere in this issue, in order to take care of the output of the mines, which in the early part of 1916 was largely in excess of the capacity of the refineries. The only new plants built in recent years, however, are the Calumet & Hecla Mining Co.'s plant at Hubbell and the Anaconda Copper Mining Co.'s plant at Great Falls. Both of these plants were started prior to the beginning of 1917. The principal increase in capacity is due to addition to existing plants.

At present the Nichols Copper Co. is the only one using the series system alone. The Baltimore Copper Smelting and Rolling Co. in its new addition uses the multiple system. The other large refineries, when increasing, simply added more tanks having the same size as those already installed. At the end of 1917 the maximum capacity of the electrolytic copper refineries in the United States was 2,788,000,000 lb., as shown by the accompanying table which also gives the capacity of these works at the end of the preceding year.

[8] "Met. and Chem. Eng.," Vol. 17, p. 682.

Metallurgy of Zinc

By W. R. INGALLS

ASK any individual zinc smelter what important new thing was started in his art in 1917, and he will probably answer "Nothing at all." Yet when we survey the whole field we see many new things, and concede that some of these may represent beginnings of important new steps in the art. The conditions of 1917 were stimulating to imagination and experimentation, to which there is never such an incentive as hard times, and strange as it may appear with spelter selling at 7½@9c. per lb., the zinc smelter has experienced hard times. As a whole, the industry is confronted with the conditions of an enormous surplus of plant, which was provided to meet the shortage of capacity in 1915 and 1916, when the demand of practically the entire world was thrown upon the United States. The surplus plant must now, to a large extent, be abandoned and written off unless some new use can be found for it. The great possibilities are manifestly to extend the use of zinc as a metal, especially in the form of sheet zinc, which may be substituted for other things; to a minor extent as zinc dust, which has some peculiar advantages, and, finally, the use of zinc as oxide, for pigment manufacture and other purposes. The following review will indicate how the thoughts of managers and metallurgists are being projected along these lines.

One of the most revolutionary ideas in the metallurgy of zinc is soon to be tested at Bartlesville, Okla., where work along this line has been going on for several years. The idea is to distill large tonnages of roasted ore in retorts, using only relatively small quantities of reducing fuel and employing relatively unskilled labor. The metallurgist will be content with a low extraction of zinc, say 60%, but will be careful not to burn any zinc during this operation. The retort residues, high in both lead and zinc, will be burned in Wetherill grate furnaces, and there will thus be obtained a zinc extraction relatively high, by rougher and less expensive methods than the present.

Another important step that is impending, I feel sure, is such improved preparation of the charge that it will be possible to introduce a great deal more ore into

the retort and reduce the great surplus of reduction material that is now employed. The possibilities of economy in this direction are immense. Methods of doing it have already been indicated.

Zinc Oxide—Several of the large zinc smelters have now provided themselves with oxide plants, the original purpose of which was to increase the extraction of the ore treated in the distilleries by a supplemental burning out of the zinc remaining in the retort residues. In a general way, residues assaying about 6 to 7% zinc can be made to yield about 60 to 65% thereof without the addition of any more fuel than the unburned surplus contained in the residue itself. The labor cost is relatively low, but the plant cost is considerable.

Metallurgically, the use of the Western Wetherill furnace is universal for this purpose, this furnace being recognized as the best all-around type. In the main, the aim is simply to make an impure oxide, which is returned to the distillery. This evades the care that is necessary to make oxide of the requisite whiteness and physical properties for use as pigment. However, some smelters have equipped themselves for pigment manufacture and have competitively entered the pigment market.

Baghouses—In zinc-oxide manufacture, the necessary element following the furnace is the baghouse for filtration of the fume. The baghouses follow the conventional lines that were first introduced many years ago. However, it is common now to provide for mechanical shaking of the bags and removal of the filtered gas by mechanical exhaustion. It has been found that the cleaner the bags are kept and the better is managed the current of gas, the more efficient is the filtering surface. Of course, these ideas simply conform to common knowledge and experience in the filtering of liquids and gases of any kind. It was sought by Simon, Buehler & Baumann to combine all the good features of the baghouse in a relatively small, compact, self-contained apparatus. This apparatus was introduced at the works of the Bartlesville Zinc Co., at Bartlesville, Okla., and has been in use there for several years. The experience with it, however, was finally decided to be unsatisfactory, and although the machines are still in use, a new baghouse of the usual type was erected in 1917 to help them out, and the use of the machines will probably be discontinued in the near future. They have been found to be mechanically weak and incorrectly designed for the handling of large volumes of gas.

Roasting Furnaces—The literature has been enriched by two very practical articles on blende roasting furnaces, one by Mr. de Lummen, the other by Mr. Chase. Zinc smelters have been for a long time in search of a thoroughly good muffled blende-roasting furnace. In default of anything better, the Hegeler furnace has commonly been used heretofore, but it is costly, clumsy, and only semi-mechanical. It is now felt that besides the Hegeler we may safely rely upon the Spirlet, the Merton and the Ridge, with a strong probability that the Wedge, with the modification that the designers have made in it to suit this special purpose, will also be found a successful furnace. Wedge furnaces are already used extensively for roasting preliminary to electrolytic zinc extraction, but that does not require the dead-roast that is necessary as a preliminary to distillation. Some Wedge furnaces have been built for the latter purpose, but they have not yet been thoroughly tried out.

The Spirlet furnace is used in this country by the Grasselli Chemical Co., by the American Zinc, Lead and Smelting Co. (Hillsboro plant), and by the National Zinc Co. Some mechanical troubles have been experienced, which may be attributed to faulty construction rather than to wrong principles of design. Under the competent direction of Mr. Rissmann, of the National Zinc Co., Mr. Harlow, superintendent of his Argentine plant, has ingeniously solved the mechanical troubles, and has, in fact, developed a new furnace, which is called the American Spirlet. Space does not permit a detailed description of this at present, but the readers of the *Journal* will have it later.

Among the older furnaces changes have been made in the construction of the Hegeler by the American Zinc, Lead and Smelting Co., which has added an extra hearth at the bottom. This hearth is direct-fired, the combustion gases going directly into the fire flues, and thus not mixing with the sulphur-dioxide gases from the upper hearths. The open roasting affords an opportunity of finishing the desulphurization in a more satisfactory manner than by the old method.

The old, wasteful Zellweger furnace is passing out of use. During 1917 three furnaces of this type of the Bartlesville Zinc Co. were changed into an adaptation of the Ropp furnace. The results have been gratifying, inasmuch as gas consumption has been reduced to less than one-half the former figure, and the roasting capacity has been slightly increased.

The introduction of the Ridge roaster has not yet been reported in this country, but in Great Britain its adoption is going on rapidly. Mr. Ridge wrote me last summer that there would soon be eight furnaces in operation at four different works. Dillwyn & Co., Ltd., have been roasting 14 to 15 long tons of Broken Hill flotation concentrate per furnace with a fuel consumption of 7½%, desulphurizing the ore to 1.4 to 1.6%, one man per shift looking after each furnace, including the fire. Vivian & Sons, Ltd., have been roasting various zinc ores at the rate of 12 to 13 tons per day with a fuel consumption of 7½%. The United Alkali Co. roasts Broken Hill concentrate at the rate of 14 long tons per 24 hours with a fuel consumption of about 9%, producing a gas containing about 6¾% sulphur dioxide. Each furnace takes about nine horsepower.

Mr. Ridge published a valuable paper on the subject of blende roasting in the *Journal* of the Society of Chemical Industry last summer. Mr. de Lummen took exception to certain of the statements therein, and it is worth while to record his corrections, in view of his interesting references to the Delplace, Rhenania and Spirlet furnaces:

"With regard to the Delplace furnace, it is said that 'only 16% of coal is required for heating.' This fuel consumption does not agree with that of the Belgian and German works, which never reaches such a level, and generally varies between 11 and 13%. I cannot agree to the assertion that the men prefer to work on Rhenania furnaces rather than on Delplace furnaces. Working on a Rhenania furnace requires much more strength than working on a Delplace, where the charges are small (between 170 and 275 lb.). Further, the

weight of the working tools of a Rhenania furnace is not to be compared with those of a Delplace furnace, which are much lighter.

"With regard to Spirlet furnaces, the capacity with Spanish, Algerian, or Silesian blende on the Continent is 6 tons per 24 hours. The coal consumption ranges from 7 to 8%. With Australian concentrates it varies from 4½ to 5 tons. I have seen several furnaces working nearly a year without being stopped. More than 70 Spirlet furnaces have been erected in Continental works."

Distillation Furnaces—I do not know of anything very important with respect to the design of distillation furnaces. In the United States, 1917 was not a year of new furnace construction, being, on the contrary, one of putting surplus furnaces out of commission. The English Crown Spelter Co., of Swansea, introduced a new furnace designed by Mr. Ruck, general manager of the company. This furnace, which is of the reversing regenerative type, is interesting as being a combination of the Rhenish and the Belgian in its superstructure. It has the three rows of retorts of the Rhenish furnace, but the arrangement of the façades follows the Belgian. In other words, this furnace is similar to those at Peru, Ill., except that it has three rows of large retorts.

Mr. Ruck tells me that after many years of consideration, he came to the conclusion that there is an economic limit to the size of the distilling furnace. (This is a subject deserving far more extended discussion than is possible here). At the English Crown Spelter Works the distilling furnaces, which compare favorably with the best of the Swansea district, have 154 retorts each, requiring a crew of nine men, the furnace men making their own gas. Mr. Ruck's new furnace has 204 retorts, and, by adopting labor-saving devices, is attended by a crew of eight men, plus three making gas for two furnaces; that is, an average of 9½ men per furnace. The men get better wages and make a considerable saving in fuel, the consumption of the latter being about 107% of the weight of the ore charged.

At Vada Ligure, in Italy, the Societa di Monteponi put one furnace in operation, this being a novelty in practice in that it is fired with the waste gas from a neighboring coking plant. The supply of gas was insufficient, however, for the other two furnaces that are contemplated. Extensive experiments in electrothermic smelting are to be undertaken at this plant. Italy is short of coal, wherefore the development of a zinc industry within that kingdom apparently lies in the direction of electrothermic smelting or of electrolytic extraction, hydro-electric power being available.

The zinc smeltery at Ekibastus, in Siberia, was put in operation, and metallurgical results are reported to have been satisfactory, but owing to other troubles the production in 1917 did not amount to much.

Some interest has been exhibited in endurance records of distillation furnaces. In the *Journal* of Mar. 31, 1917, it was reported that on Mar. 12 block "C," comprising 600 retorts at the Cherryvale works of the Edgar Zinc Co., had completed a campaign of 10 years, during which time it had produced 29,136 tons of spelter. During the 10 years smelting was interrupted for 15 days owing to labor troubles and for 15 days owing to breakage of gas mains, but during those times the furnace was on dead-fire. The end of the 10-year period did not terminate the compaign of this furnace.

The record of this Cherryvale furnace is surpassed by that of several furnaces in the Clarksburg works of the Grasselli Chemical Co. In May and June, 1904, the first three furnaces of this plant were fired. In 1905 three additional furnaces were started and the remainder in 1907. None of these furnaces has missed a single fire or has had to have any repairs worth mentioning. They are reported as doing at present as good work as they have ever done, and Mr. Ziesing considers that their campaign will continue for many years yet.

Zinc Dust—One of the projects for increasing the use of zinc is to produce a superior kind of zinc dust, which will not only replace the furnace blue powder, but also will find new uses. The new kind of dust is produced by atomizing zinc by means of compressed air. This is already being done by the Anaconda Copper Mining Co., by the Grasselli Chemical Co., by the New Jersey Zinc Co., and by the Metals Disintegrating Co., of Boston. The National Zinc Co., of Bartlesville, Okla., has begun experimenting on the same lines.

The greatest difficulty in atomizing zinc is to produce a product that is as fine as furnace blue powder, but that difficulty has been mastered. Atomized zinc dust, when of proper fineness, is greatly superior to furnace blue powder. The atomized dust runs in the coarser sizes from 98 to 99% metallic zinc, and in the finest dust, all of which passes through a 350-mesh sieve, there is 97 to 98% metallic zinc. Furnace blue powder made in the United States hardly ever contains more than 86% metallic zinc, though it is reported that some is now made running as high as 90% metallic. Furnace blue powder is naturally of greater fineness than the majority of the atomized product now on the market, but it is possible to prepare the latter as a very fine and very beautiful product.

Electrolytic Zinc Extraction.—During 1917 several of the new plants went into operation, but none attained large production. On Dec. 25 the plant at Risdon, Tasmania, was put in motion. The Mount Lyell company will also probably build in that island.

Early in 1917 the Judge Mining and Smelting Co., of Park City, Utah, put its electrolytic zinc plant in operation, producing about three tons of zinc per 24 hours, which was gradually to be increased to 12-15 tons. This plant, which was designed and built by C. A. Hansen, is especially interesting from the fact that it is the first zinc plant to be equipped with rotating, circular cathodes. That is to say, it is the first modern plant using zinc-sulphate electrolyte. Dr. Hoepfner employed such cathodes in the old plants at Führfort, in Germany, and at Winnington, in England, but at those plants the electrolyte was zinc chloride. Rotating cathodes offer some distinct theoretical advantages, against which there are some disadvantages (among which is considerably higher first cost). However, the experience at Park City soon demonstrated that the disadvantages outweighed the advantages, and stationary cathodes were substituted.

Otherwise there were no great novelties in the electrolytic process. At Anaconda it is considered to have passed out of the "high brow" stage and to have be-

come a matter of everyday working. Many of the initial difficulties have disappeared. As Mr. Laist says, "they seemed to be like evil spirits, which ran away when they found they could not baffle us."

Refining by Redistillation—As in 1916, a great deal of common spelter was refined by redistillation up to grades —0.10% Pb, —0.15% Pb, etc. In the West this is done by redistilling in furnaces that are adaptations from the ordinary ore furnace, the retorts being inclined upward instead of downward. The spelter is either charged in sticks or as molten metal (de Saulles furnace). In the East furnaces with large, bottle-shaped retorts, similar to those of the Faber du Faur furnace, are employed. In Sweden the redistillation is done in electric furnaces. Mr. Ziesing, of the Grasselli company, has designed an electric furnace for this purpose, but it has not been tried in practice. The lack of interest in electric furnaces in this country is ascribable to the relatively high cost of power as compared with conditions in Scandinavia.

Sheet-Zinc Rolling—The New Jersey Zinc Co. built a rolling mill at Palmerton. We may expect a great increase of interest in the subject of sheet-zinc rolling in the United States during the next few years.

Progress of Flotation in 1917

BY HERBERT A. MEGRAW

THE progress recorded by the flotation process in 1917 was considerable, but most of it failed to come before the public eye. The process was the subject of a great deal of discussion, however, because of the prominence imparted to it by extensive litigation. The appearance before the U. S. Supreme Court late in 1916 of the case of Minerals Separation against James M. Hyde apparently served as a starting point for a new series of controversial arguments. In 1917 the cases of Minerals Separation vs. Miami Copper Co., decision upon which was filed May 24, and the case of Minerals Separation vs. Butte & Superior Co., later in the year, provided further incentives for discussion. In all of these decisions there has been room left for discussion of their real intent, since the language used was not sufficiently clear to provide an unalterable conclusion. Under such circumstances the operator must simply wait for the time when he can be advised without fear of contradiction.

THE PROGRESS OF FLOTATION LITIGATION

The situation, so far as the legal status of the process is concerned, is badly clouded, and it would require the careful study of an expert to arrive at a conclusion that might form a basis upon which practical operations could be conducted. The claims made by Minerals Separation, the owners of certain patents that they insist are basic, and those of other inventors and operators, are so broad and overlapping that they do not agree at any point, and no one could safely make use of the process in any way without danger of becoming involved in litigation. In this regard, the paper by R. C. Canby, in the *Engineering and Mining Journal* of Dec. 1, 1917, performs a most useful service by reviewing the field of patent litigation and pointing out just where the different processes and claims may be substantiated.

Much of the agitation about the legal phase of flotation centered about the use of oil, the quantity or proportion to be employed, and the method and degree of agitation. The decision of the U. S. Supreme Court in December, 1916, apparently limiting the claims of Minerals Separation to the use of 1% of oil or a smaller amount upon the dry weight of the ore treated was the signal for many operators to modify their operations to the extent of using larger quantities of oil. Whereupon, Minerals Separation, in order to avoid this limitation, secured a revision of one of its claims in the patent in question, amending it to read in such a manner that the Minerals Separation company apparently made no claim to the use of more than 1% of oil "except where the results obtained were the same as the results obtained with less than 1% of oil." By this skillful wording the whole subject was reopened. Minerals Separation, particularly in the suit against Butte & Superior, pointed out that, although quantities of oil much larger than 1% were used, the results were still the same as where less than 1% was employed, and that the actual flotation results obtained were through the small quantity of appropriate oil applied in the process, and not through the use of the much larger quantity of what they claim to be an inappropriate oil. They pointed out that the larger quantity of oil was of a kind not suitable for flotation and was merely introduced to avoid patent infringements, being in effect a subterfuge.

CLARIFICATION OF COURT DECISIONS

It is not the province of this article to go deeply into the subject of litigation. It has been discussed at length in the columns of the *Engineering and Mining Journal* and other technical periodicals, particularly in the article by Mr. Canby, already mentioned, which serves to illuminate the situation as it was on Dec. 1, 1917. Technically, it may be pointed out that a great number of plants operated with the employment of large quantities of oil—that is, quantities amounting to more than 1%—upon the dry weight of the ore treated, while a considerable number of experiments were made and some practical progress was obtained toward flotation without any oil whatever. This, of course, does not refer to the oilless surface-film processes, which are clearly outside Minerals Separation claims, and which may be and are utilized generally in the United States and other countries. It does apply, however, to processes that give the same effect as the oil-using methods. Of course, the use of reagents other than oil to produce a condition of froth such as will support commercial concentration by flotation will probably become the source of further litigation should it become practicable, since Minerals Separation is the owner of a patent that is said to cover the use of all soluble frothing agents. This seems to be a remarkably broad patent and to cover methods that might be invented or discovered in the future as well as those known at the time the patent was issued. Naturally, there will be differences of opinion on the subject, and litigation to settle the point. On the

face of the matter it would appear that the terms of this patent may be so interpreted as to cover almost anything, since if a substance is not soluble, it is difficult to see how it would influence froth formation.

The question of the kind of oil to be used in flotation was the subject of further study, and, while little public notice was taken of the matter, it is believed that a number of practically new products were adapted during the year. As it stands now, it seems possible that almost any oil may be used in flotation, but what the qualities of an oil are that make it desirable for the purpose is not clear. To this latter point one or two research laboratories directed particular energy, in the endeavor to find a basis by which oils may be judged without going through actual tests on the ore itself. The object was to define the quality or qualities that make an oil appropriate for use in ore flotation. The prospect is bright for the discovery of some such basis in the not distant future.

Royalties and Their Payment

One of the principal points that attracted the attention of the outsider in flotation litigation was the strenuous effort made by operating companies to avoid royalty payments to Minerals Separation, the principal patent owner. Indeed, it was publicly urged that operators purposing to take advantage of a process of this kind ought to be willing to pay a reasonable royalty to the inventor of a new and useful method. The opponents of Minerals Separation, however, maintained that they would be perfectly willing to pay a reasonable royalty but were not willing to comply with the terms specified by Minerals Separation. It was pointed out that Minerals Separation claims impose a severe tax upon the mineral industry, and that, in addition to the actual money payments, the corporation insists upon becoming the owner of any process or improvement along flotation lines that may be discovered by its licensees. If the last and additional requirement could be enforced the effect would probably be to deaden the ambition of operators, since it would leave no incentive for the development of new ideas, and apparently it would be much better, even for Minerals Separation itself, to open the way for free improvement of the process along every possible line. Minerals Separation might well stand upon its original rights, drawing an income from royalties and at the same time not hampering general development of the process.

It was further contended by opponents of Minerals Separation that the basis upon which royalties are charged is not logical. The company seeks to impose a royalty upon the total tonnage of ore treated by a given plant; whereas, the operators contend that this charge should be assessed upon the tonnage of ore actually treated by flotation. The basis of the claims of the opponents is evident without discussion, but Minerals Separation's ground for argument is not clear without further explanation. It is that if the charge is made upon the tonnage actually treated by flotation, the operators using it will endeavor to limit its application to as small a tonnage as possible, thereby not only depriving Minerals Separation of the royalty that might rightfully be theirs, but, in addition, operating actually to the detriment of the process itself, since its efficiency might be impaired by the efforts of operators to economize. The value of this argument may be weighed by each operator in the light of its application to his own problem and the conclusions reached will doubtless be expressed from time to time.

Effect of Variations of Quantity of Oil

Technical applications of flotation in 1917 were developed to a considerable extent, but a great amount of data was not made public. Some descriptions of new applications were published, however, and it is best in a review of the subject to confine one's self to the points to which public attention was directed. It is unwise to mention those plants at which developments have been kept more or less secret, although some reference to the work in general terms may be made without particular reference to the plants themselves.

Although the use of more than 1% of oil in securing flotation of minerals was more or less widely considered as a subterfuge to avoid patents, there were some instances in which the increased amount of oil was of considerable benefit. In cases where extremely muddy water had to be contended with, that being the only supply available for flotation, the increased amount of oil delivered better concentrates, cleaner and more of them, than when the smaller quantity of oil, as specified by the patent, was used. In other cases the larger quantity of oil produced concentrates that contained a much greater percentage of the mineral content of the ore, although they were low grade. This simply meant that the material had to be put through a second operation, that of cleaning, resulting finally in a product that was satisfactory in grade, and at the same time delivered a high percentage of the mineral content of the original ore.

The subject of oil received considerable consideration, as has already been said, but it is probable that few if any new oils were brought into practical use during the year, as in 1915 and 1916 experimenters tried practically all available oils to determine their use in flotation. It is possible that some of the shale oils and bitumen products were experimented with during the year.

Flotation in the Joplin District

Among the advances recorded in 1917 may be mentioned the plants of the Southwestern Missouri lead and zinc fields. C. A. Wright described[1], the ore-dressing practice in the Joplin district, pointing out that flotation tests of the ores show that they are amenable to flotation and that the sulphide floated rather easily. He further said that, "although for the present flotation may not prove as important in the mills of the Joplin district as in many of the larger copper and zinc mills of the West, it is believed that before long many of the mills of the district will have small flotation units for saving a large proportion of the values in the fines now going to waste. Several mills are already using flotation successfully; with others it is still in the experimental stage."

In the Joplin district many tests showed that a fairly good grade of concentrates could be obtained by the use of rougher and cleaner cells. Oils having a coal-tar base gave high recovery but low-grade concentrates, while other oils gave better grade of concentrates but not such

[1]Bull. A. I. M. E., No. 130, October, 1917, p. 1565.

good extractions. The best ultimate results were obtained by the combined use of wood creosote and pine oil. These with petroleum products form a mixture that is satisfactory, a typical combination being 80% coal tar and 20% pine oil or creosote.

Turpentine and Rosin as Frothing Agents

Several tests were made with a mixture of turpentine and rosin. The rosin was dissolved in the turpentine in such proportions that the three different mixtures used contained 10, 20 and 30% of rosin, respectively, the remainder being turpentine. The experiments made were mostly roughing tests to find out what the mixture would do with respect to grade of concentrates and percentage of recovery. The 20 and 30% mixtures gave the best results in both respects. By using from 1 to 5 lb. of mixture per ton of ore treated in an acid pulp of about 5: 1 thickness, that is, water to solids, the rough concentrates varied from 37 to 66% zinc, and the zinc recoveries from 50 to 80%. In most cases the higher the grade of concentrates obtained, the lower the recoveries. The relatively low recoveries, however, may be considered good in view of the fact that the zinc content of the heads was low, being 1.05 to 2.18%. It was believed that higher recoveries might easily have been obtained had there been richer feeds available.

The work done in the experimental way was checked by sending samples to Salt Lake City, where the U. S. Bureau of Mines, in coöperation with the University of Utah, is doing flotation experimental work. The results of the tests performed by Messrs. Ralston and Allen demonstrated that it is fairly easy to float the sphalerite from the gangue by using warm solution and about 1 lb. per ton of any suitable oil, either from wood or coal distillation, and that acidity, although it does not seem to be necessary, allows the froth and fluid to separate more quickly. Cold solutions give a higher recovery than warm ones, but the grade of product is not so good.

The Practice in Southeast Missouri

Describing concentration practice in Southeast Missouri, A. P. Watt, said[2] that the introduction of flotation in the district had not greatly altered the metallurgy of the ores. Flotation is not replacing gravity concentration except in the very fine sizes, and economically never can replace it. Fortunately, the physical nature of the ore of the district is such that an economical product can be made on the jigs and tables, and this fact precludes the possibility of flotation ever encroaching into the field of gravity concentration. The logical use of flotation in the district is in the treatment of galena particles finer than 200 mesh, as efficient work can be done with tables on sizes coarser than this. The field for flotation thus appears as sharply defined, being limited to the treatment of slimes products only, no attempt being made to displace gravity concentration by flotation on sizes coarser than 200 mesh.

In the Southeast Missouri district the usual feed for flotation is the overflow of the desliming cones, classifiers, jigs, drags, and other like sources. Primary and secondary slimes are mixed. The overflows may be partly tabled or may all go direct to the flotation plant without gravity concentration. The mill slimes, containing 3 to 10% solids, are settled, usually in Dorr tanks, the settling area allowed per ton of dry slimes varying from 11 to 16 sq.ft. An average figure for the district would be about 13 sq.ft. per ton of dry slimes. This figure applies when the discharge contains 20% solids. The lead present in the discharge of the Dorr thickeners is practically all finer than 200 mesh, which is the desirable product for flotation.

Adding the Frothing Agents

The frothing agent is added at the flotation machine. The common agent is creosote, which gives excellent results, is active and yields clean concentrates. Some plants add the entire quantity of creosote at the first flotation compartment, and even though the tailings from the primary machine may be retreated, no further addition of creosote is made, entire dependence being placed upon the initial quantity added. The more common practice with the agitation type of machine is to add the frothing agent at several points. At one plant operating a 24-compartment agitation machine, of the total creosote used 75% is added at the first compartment, 13% at the ninth compartment, 8% at the 16th compartment, and 4% at the 21st compartment.

The types of machines used are Federal, Janney, the drum and the pneumatic. The pneumatic-type machine is never used as a primary treater, being limited to retreatment. The Federal machine is similar to the standard agitation type, consisting of an agitation compartment and a spitzkasten. It was developed by the Federal Lead Co. These machines are usually preceded by two preliminary agitation cells without frothing compartments, these two being necessary in order to incorporate thoroughly the frothing agent into the pulp. The Janney machine is fairly well known and needs no further description, while the Kohlberg & Kraut is of the drum type,

The flotation practice at all the plants is similar, differing only in detail. The tailings from primary treatment are retreated, either with air machines or drum-type machines; the latter make finished tailings, and concentrates that may be finished or may require retreatment. The drum-type machines recover much of the pyrite that escapes the primary machines. The concentrates from the drum tailings machine are finished product, requiring no further treatment.

Flotation as an Auxiliary Process with Arizona Copper Ores

"Concentration at Humboldt, Ariz.," describing the work of the Consolidated Arizona Smelting Co., by George M. Colvocoresses, in the *Engineering and Mining Journal*, of July 14, 1917, included details of flotation as applied to those ores. It pointed out that the advent of flotation worked a considerable change in smelting conditions and practice, not only making possible the profitable treatment of many ores that could not be successfully handled by gravity, but as an adjunct to gravity concentration greatly improving the recovery of metals and the grade of concentrates produced.

The commercial minerals in the Consolidated Arizona ores float satisfactorily, and when clean sulphide is sent to the mills an excellent recovery is obtained, sometimes running as high as 95 or 96%, including the

[2]Bull., A. I. M. E., October, 1917, p. 1525.

recovery made by the roughing tables. Various mixtures of oil have been tried there, the average mixture consisting of 67.7% of the Standard Oil Co.'s stove oil; 25.7% of Pensacola Tar and Turpentine Co.'s No. 200, and 6.6% of other oil. On the average about 1.387 lb. of oil per ton of ore was employed, its cost representing just about 3c. per ton of ore. A newer mixture in use consisted of 70.4% of Standard Oil Co.'s stove oil; 24.9% of Pensacola Tar and Turpentine Co.'s No. 200, and 4.7% of Standard Oil Co.'s Calol fuel oil. The amount used per ton was 1.31 lb., and its cost about 2½c. per ton. The figures given for the cost per ton of the concentration at this mill are interesting, and are as follows: Crushing, $0.391; grinding, $0.571; tabling, $0.2625; flotation, $0.250 per ton.

Murex Process Uses Flotation Principle

At Darwin, Calif., concentration of lead-carbonate ores was accomplished by the Murex process, described by H. S. Rexworthy. As is well known, this process consists of mixing a magnetic mineral with oil so as to form a paint, and agitating this with the ore to be treated, whereby the magnetic paint adheres, by virtue of the oil, to the valuable mineral. The latter is then separated by a magnetic separator from the bulk of the ore. This process is carried out successfully at Darwin, one of the important considerations being the cost of the treatment. Here the figure is $1.7805 per ton. It is pointed out that the Murex process requires that the ore be ground only fine enough to liberate the valuable mineral, and that sands and slimes may be treated together in one operation, so that no classification is necessary.

Flotation is described in the practice at the Burro Mountain concentrator, by F. C. Blickensderfer, in the *Engineering and Mining Journal* of July 14, 1917. The fine sands are floated, using Rork drum-type machines.

In general it may be said that flotation is steadily increasing its hold upon the mining industry and widening its field of activity. There have been, however, some instances where flotation, once tried, has not proved satisfactory and had to be eliminated from the flow sheet. This, of course, is nothing against the process, but simply shows that it is not a cure-all, which the wise operator already knew. The proper thing to do is to limit its activities, to find out just exactly what kind of ores can be successfully treated by it, and not to attempt to extend its application into fields in which it is not of practicable utility.

Metallurgy of Gold and Silver

By HERBERT A. MEGRAW

THE story of gold and silver during 1917 presents no record of noteworthy metallurgical advances. Most of the attention of the operators was devoted to the production of metal on the greatest possible scale, and metallurgical experiments received small consideration. It is true, undoubtedly, that processes were improved, but more was done in the way of development, along standard lines, of the usual processes, and little or nothing toward the origination of entirely new methods was accomplished.

No Metallurgical Developments for Gold

In the metallurgy of gold there is practically nothing to record. Gold was produced during the year at about the usual rate and there were few, if any, new properties opened. The general rise in cost of material and supplies used in mining and metallurgy was rapid during the course of the war and, in 1917, due to the entry of the United States into it, the rise was more pronounced. Since there was, of course, no change in the nominal selling price of gold, the advance in general cost was practically equivalent to a decrease in the value of the metal. Consequently, its recovery was considerably less profitable than in former years. Nevertheless, the metal was produced at about the usual rate.

The great gold mines of the world did not, with slight exception, slacken their activities where political conditions allowed operations to be carried on. The exception, of course, refers principally to Mexico, where the El Oro camp was not able to produce at its normal capacity. The gold production of Mexico, in general, was less than normal. The metallurgy did not change at all. Practically all of the metal was recovered by fine grinding and cyanidation, as for the last 10 or 15 years. In the Porcupine gold district in Ontario there was a slackening of production in the latter part of 1917 and one important mine ceased milling on account of increased cost, uncompensated for by increased price of the product.

Gold Metallurgy in Mexico

The Mexican metallurgy, as it has been standardized, consists of breaking the ore primarily in breakers, crushing it in stamps, and regrinding it in tube mills. The grinding process is sometimes divided into two parts, producing sands and slimes, or, in many cases, producing slimes only, a minus 200-mesh material being produced for the all-agitation treatment.

Concentration finds little part in Mexican gold metallurgy, the ground ore being almost exclusively treated by the cyanide process. Agitation is carried on in tanks of various types. Sometimes the Pachuca tank is used, but it is noteworthy that few are being built nowadays. The ordinary flat-bottomed, round tank is still employed to a great extent, simply because installations were on hand and it has not seemed commercially advisable to replace them with new tanks of a different type. The Dorr agitator has had considerable success, and, as a means of agitating at an extremely low cost, it can hardly be improved upon. The patented types of rapid cyaniding machines, several of which have appeared on the market during the last four or five years, have been uniformly unsuccessful. They were usually offered by persons who attempted to set aside the basic principles of chemistry involved in dissolving metals in cyanide solutions, and they were not able to oppose them. The time necessary to dissolve metal in cyanides cannot be radically reduced by any known method, and, although

proper manipulation designed to expose the greatest quantity of metal to the cyanide solution in a given time will afford notable time reductions for dissolving, the process is one involving considerable time and is hardly capable of being reduced to a minute basis.

Practice Standardized in South Africa

The metallurgy of the great gold mines of the Rand, of South Africa, continued to be operated in the usual way. The gradual but steady decrease in the average value of the ore of the older mines made economies necessary, from time to time, and development was toward perfecting the processes already in use.

As has been the case for many years, cyaniding was the principal process for the recovery of gold in South Africa, and little change was made in it except for the refinement and simplification of the essential factors.

From all the information obtainable, the same holds good with the Australian and New Zealand production of gold. Standard methods, used for years, were still practiced, development rather than new invention being the order of the day. In both these latter countries, the question of labor had a good deal to do with production, the enormous drain of men for war purposes showing upon this as well as upon all other industries.

Thus, it may be said in general that the metallurgy of gold throughout the world followed in 1917 much the same lines as in the immediately preceding years, no metallurgical development of major importance being made; improvement of existing processes and details of those processes were the principal factors to be noted.

The Changed Situation of Silver

With silver the case was, of course, entirely different. The rapidly increasing price of the metal during the latter half of 1917, reaching a maximum at one time of more than $1 an ounce, was sufficient to put an added impetus into production. Here, again, metallurgy was rather at a discount, while increasing the volume of production was the important object in view. Many old mines in production years ago, and some dead for the last two years, were reopened and brought into profitable production. Producing mines were still further stimulated and every effort was made to take fullest advantage of the increase in the selling price of silver.

The silver situation brought about a rejuvenation of the mines of the Cobalt district, of Ontario, Canada, where the maximum ore values are a matter of history, and the camp was facing the necessity of developing its metallurgical processes so as to produce the metal in the most economical manner. The high price of silver, however, during the year brought another era of profit to the camp, which was fully appreciated and full advantage was taken of it. The mines at the close of the year were working to their fullest capacity, that is, in so far as they were able to get necessary labor, and some of the older mines were being reopened, new ones developed, and even some of the failures were again put in operation.

Silver Metallurgy in Canada and Mexico

There was considerable metallurgical advance in Cobalt, and this consisted principally in the application of flotation to the ores of the district. In many cases, it proved eminently satisfactory, and it is to be expected that the application of the process will widen and that it will be responsible for increased recovery from portions of the ore that heretofore have been rather poorly taken care of. Several of the mills now have flotation plants that are doing well. This subject will be mentioned again in further detail.

The silver camps in Mexico were in poor shape at the close of 1917. Perhaps only about 40% of the normal production of silver is coming out of that country, and it is not to be expected that there will be any great increase in the near future. Many Mexican producers attempted to take advantage of the high price of silver and get out large quantities of it but, while it is a comparatively simple matter to operate the mines, transportation is in such a chaotic condition that nobody can depend upon getting the necessary supplies for operation nor for safely exporting the bullion when it is produced. The conditions have been discouraging and, while it is known that some of the well-known operating companies are attempting to increase their working scale and some smaller operators have gone into the country to institute operations, there is nothing so firmly established that any dependence can be placed upon it.

The metallurgy of the Mexican silver ores is of considerable importance, since silver is the principal mineral product of Mexico, and that country is, in normal times, the greatest producer of silver. Naturally, therefore, the silver metallurgy of Mexico has always ranked high and has commanded the serious attention of the world.

Flotation in Mexican Silver Ores

During the last two years Mexican silver producers were considerably annoyed, first by the political conditions that hampered work of any kind, and secondly by the war, which put a sudden stop to importations from Germany, the principal source of cyanide. This, with the difficulty of transporting it, or anything else in Mexico, resulted in a deadening of the silver-producing industry, and it closed the year considerably below normal.

The difficulty of obtaining cyanide led to experiments upon the ores to devise some other way of treating them, and flotation appears to have been useful. The principal silver mineral of Mexico is argentite, the sulphide of silver, which is susceptible to flotation. Experiments made at the Santa Gertrudis plant, in Pachuca, showed that it is possible to obtain a good extraction of the silver sulphide by flotation. As a matter of fact, the plant requirement is much less than with the cyanide process; it is cheaper to install and more economical to operate. Of course, there is the consideration that the product of the flotation process is not bullion, but is a material that requires further treatment to put it in merchantable state. It has been found, however, that wherever a smelting plant is available, it may be employed profitably. At isolated plants, where it is difficult to ship the concentrates, provision may be made for treating them by regrinding and cyanidation at a comparatively low cost. The outstanding features of this system are that the flotation concentrates represent most of the valuable content of the ore in such a small bulk that it is practicable to use strong cyanide solutions and greater lengths of time to extract the silver, which may be practically all recovered.

Not only in Mexico has flotation been applied to silver ores, but also in various parts of the United States and Canada. In one Arizona silver-producing mill, the shortage of cyanide led to experiments with flotation, the latter giving such excellent results that the cyanide plant was dispensed with and a permanent flotation system installed. In other cases, of course, it has been found advisable to use the cyanide process in connection with flotation, the flotation being an auxiliary of more or less importance, depending upon the character and grade of the ore under treatment.

Metallurgy of the Cobalt Ores

In the Cobalt district of Ontario, Canada, flotation has proved a valuable adjunct to the concentration and cyanide systems in use. Concentration plants, that is, plants originally equipped to treat the ore only by gravity concentration, have been able to secure materially improved results, often reaching to more than 10% addition to the recovery. The additional cost of flotation is usually less than 20c. per ton, and often much less. Some cases are on record where the cost is less than 5c. per ton. Of course, this does not include crushing or grinding, or other details of the metallurgical process. The Cobalt ores seem to require, in addition to the ordinary frothing agents, an oil that will be strongly adhesive to minerals, and this condition is usually fulfilled by using tar. The Cobalt flotation oil consists principally of creosote with a small percentage of pine oil and still less of the tar. Recovery by flotation in Cobalt, as has been said, runs up to 90%, although it is sometimes as low as 70 per cent.

Comparing Flotation and Cyaniding

In a paper by Robert E. Dye, read before the Canadian Mining Institute early in 1917, the cost of treating the accumulated tailings of the Buffalo mine by flotation and the comparative cost by cyanidation are given in detail. The flotation cost, producing concentrates, was 74c. per ton, while the cost of cyaniding was $1.62 per ton. Since the flotation concentrates are not a finished product and the bullion from cyanidation is, the comparison on this basis is not altogether fair, so the smelter charge, including freight and losses, of 83c. was included with the flotation cost, which brings the total up to $1.57 per ton, as compared with the cyaniding cost of $1.62 per ton. The same recovery was obtained both by flotation and by cyaniding and, as can be seen from these figures, the costs are pretty nearly the same. There is this advantage in flotation, however, that it is a newer process and the possibilities for cost reduction are considerably greater than is the case with the cyanide process, which has been in use many years and is highly perfected. An additional advantage in favor of flotation is that its installation cost is considerably lower than is the case with a cyanide plant. Of course, where the two processes have to be used together, no such advantage may be claimed, but where one process is being weighed against the other for a complete installation, flotation has a large advantage over cyanide, both in the cost of the plant itself and in the smaller space occupied by the installation.

The system of crushing and grinding gold and silver ores is still in a state of evolution, the opinions of various authorities differing. One system includes a short crushing stage, employing gyratory breakers, jaw breakers, rolls and tube mills, or the series may be further shortened by using gyratory breakers, ball mills and tube mills. Each system—and many modifications—has its adherents and no conclusions are yet possible.

Few Crushing and Grinding Plants Installed in 1917

The question of crushing and grinding was not changed much in 1917. So few new plants were installed that it is difficult to make any assertion as to the kind of crushing machinery toward which the industry is tending. It is certain, of course, that the stamp mill has had its day and that other machines are sure to replace it on a constantly increasing scale. The success obtained by ball mills of different kinds assures the retirement of the stamp. The only question is, what kind of a ball mill? There are many types on the market, varying from the standard plain cylindrical ball mill to the Hardinge conical type or the Marcy cylindrical grate mill. The success of both the Hardinge and the Marcy mill in the big copper properties is leading to their introduction in gold and silver metallurgy. Both are being installed to a considerable extent, and it seems probable that their use will increase. The Marathon mill, which is a cylindrical tube mill, grinding by means of steel shafts instead of the usual balls, did not, apparently, have any great increase in its application during the year. Its use in Arizona, as described by Blickensderfer before the American Institute of Mining Engineers in 1916, still persists. It is said that a number of these mills were installed in different plants, but the results obtained were not made public on such a scale as to attract particular attention from the engineering fraternity in general.

For fine grinding, or regrinding the oversize portion of the classified ball-mill product, dependence is still placed on the tube mill. This device has yet to be improved upon for delivering very finely ground pulp at reasonable cost. The design of the tube mill is changing somewhat, however, and is more closely approximating the dimensions of the ball mill, reaching greater diameters and shorter lengths, particularly the latter.

As a general proposition, it may be said that there was little change in the metallurgy of gold and silver during 1917. This is more strictly true as regards chemical changes than mechanical. There certainly was produced no process or development that involves a chemical basis not heretofore used. Mechanical improvements were, of course, along the line of development, improvement of results so far as extraction is concerned, and reduction of costs. In the United States all of the old standard plants are following their usual course. The California gold mills, those of Nevada, such as the Goldfield Consolidated, the Homestake, in South Dokota, and the other standard plants are running as usual. The gold mines of the Porcupine district, Canada, are operating in the usual way, with the exception of the Dome, which ceased milling in December on account of the general advance in operating cost.

The big silver plants are working along in the same way, and no change is to be expected in the immediate future. Volume production is the requirement, and the silver mines of the country are being forced to deliver the greatest possible amount of the metal.

Economic Geology

By ADOLPH KNOPF*

G. K. GILBERT analyzed in masterly fashion and with far-ranging vision the problem created by the hydraulic-mining débris in the Sierra Nevada (Professional Paper 105, U. S. Geol. Surv.). Since the beginning of hydraulic mining, 1555 million cubic yards of tailings have been moved, a volume nearly eight times as large as the material excavated in making the Panama Canal. In a full consideration of the débris problem there must be added to this amount the volume of débris from other forms of mining (140 million cubic yards) and the nonmining waste (700 million cubic yards), making a total of 2365 million cubic yards that has been moved in the region tributary to Suisun Bay, at the head of the San Francisco Bay system.

Control of Mining Débris in California

A large part of the tailings from the hydraulic mines was deposited at the base of the range, where it encroached upon the valley lands and also intensified flood conditions. The agricultural interests thus endangered forced the enactment of restrictive anti-débris legislation, and as a result hydraulic mining has practically ceased. During this cessation of hydraulic mining the streams have been steadily deepening their channels and restoring them to their pre-mining state, and under conditions now being produced by engineering works to control flood waters in Sacramento Valley, the capacity of the rivers in the valley to transport débris will be increased, so that hydraulic mining might now be partly resumed without harm to any valley interest except navigation. Gilbert shows, however, that a far greater interest—that of the commerce passing through the Golden Gate—should now dictate that the débris be controlled. For since the discovery of gold, 1146 million cubic yards of débris and soil waste have been deposited in the San Francisco Bay system, not only shoaling the waters, but also reducing the area of the bays. The volume of the tidal prism was thus decreased, thereby diminishing the strength of the ebb tide through the Golden Gate. As the velocity of the tidal currents is one of the two factors determining the depth of water on the bar outside the Golden Gate, the matter becomes of prime concern to the port of San Francisco. The other factor—the supply of sand brought to the bar by wave attack on the ocean cliffs—is constant and cannot be controlled. It is therefore imperative to control and prevent mining débris from being carried to the bays. As to the outlook for the renewal of hydraulic mining on a large scale with storage of débris, Gilbert believes that mining can be resumed only in coöperation with enterprises undertaken to develop the waters of the Sierra Nevada for irrigation and electric power.

Enrichment of Ore Deposits

"The Enrichment of Ore Deposits" (Bull. 625, U. S. Geol. Surv.), by W. H. Emmons, is an amplification of an earlier report on the enrichment of sulphide ores (Bull. 529), published in 1913. The scope of the report has been broadened and is no longer limited only to enrichment by secondary sulphides: all forms of enrichment effected during oxidation are considered; furthermore, details concerning the behavior of 15 chemical elements and their mineral compounds in the zone of oxidation, not discussed in the earlier report, have been added. Emmons points out that the theory of secondary-sulphide enrichment dates back farther than has been previously recognized. As long ago as 1854 Whitney applied the theory to account for the rich mass of bluish-black copper sulphide that occurred below the gossan at Ducktown, Tenn. Although the fundamental principles of the theory were clearly grasped by Whitney, it was not until 1900, after their rediscovery and announcement by S. F. Emmons and others, that they gained general recognition. Since then they have stimulated an enormous amount of fruitful research, and in the present volume W. H. Emmons has skillfully marshaled the results in convenient, usable form. It is an invaluable work for all those interested in the geology or chemical problems of secondary-sulphide enrichment.

Disseminated Copper Ores

In "The Geology and Ore Deposits of Ely, Nevada" (Professional Paper 96, U. S. Geol. Surv.), A. C. Spencer gave the results of the first monographic study of some of the great deposits of disseminated copper ore—the so-called porphyry coppers. At Ely, the primary sulphides, which average about ½% of copper, were deposited early in Cretaceous time, shortly after the intrusion of monzonite porphyry into a series of Paleozoic limestones, quartzites and shales. They are believed to have been precipitated from magmatic waters that escaped from the differentiating porphyry magma. The whole process of primary mineralization appears to have lasted a definite and rather short interval of time, and because the paragenesis of the metallic sulphides fails to indicate that the mineralizing solutions progressively changed in character during sulphide deposition, it is thought that the solutions had about the same composition throughout the chief epoch of mineralization, and that this epoch ended abruptly as the result of a critical change that occurred in the differentiating magma from which the solutions were derived. The sulphides were deposited zonally with respect to the axis of the central line of porphyry masses. Iron and copper sulphides were deposited nearer the axis, and lead and zinc sulphides farther out. This distribution is interpreted not, as is commonly done, as a result of the greater solubility of lead and zinc sulphides, but as due to their far smaller concentration in the ore-forming solutions relative to iron and zinc. The redistribution of the copper to form ore in the masses of pyritized porphyry resulting from the primary mineralization is thought to have been accomplished by the beginning of Quaternary time.

Billingsley and Grimes (Bull. 124, A. I. M. E.) described briefly the ore deposits occurring in the area of the great granitic intrusion in southwestern Montana, known as the Boulder batholith, and formulate some important generalizations concerning the origin of the deposits. For the deposits genetically related to the Boulder batholith they recognized three stages of ore deposition, which they term respectively the granite, ap-

*U. S. Geological Survey, Washington, D. C.

lite, and quartz-porphyry stages; that is, the successive intrusions, which are differentiates from a common magma, were each followed by the deposition of ore. The evidence presented indicates that successive magmatic differentiates were followed by successively greater deposition of ore, but Grimes and Billingsley drew the hypothetical conclusion that successive differentiates were followed by increasingly larger proportions of vein-forming solutions. The mineralization of the quartz-porphyry stage occurred only in the Butte district, the copper deposits of which are referred genetically to the quartz-porphyry intrusions. The restriction of these intrusions to the Butte district is believed to be one of the reasons why the ores of the district differ so strongly from those of the other districts of the Boulder batholith. The great number and richness of the copper deposits indicate that the local portion of the granite magma was unusually rich in copper. The great vertical range of the copper ores at Butte is thought to be due to long continuance of mineralization and the downward migration of the level at which ore was deposited during the period of ore deposition.

Gold and Silver Ores

R. B. Young gave in "The Banket: a Study of the Auriferous Conglomerates of the Witwatersrand and the Associated Rocks," an attractive work on the Rand gold deposits. The volume, which is based largely on a series of earlier papers by its author, is a concise, well-written and well-illustrated work. It is chiefly petrographic, and although Professor Young formerly adhered to the infiltration hypothesis, he now supports the hypothesis of the placer origin of the gold in the Rand deposits. The original detrital gold is thought to have been dissolved and redeposited essentially at the place where it was dissolved, and the pyrite, which averages 3% of the banket, has been formed by the sulphidation of detrital magnetite and ilmenite. Tourmaline generally occurs in abnormal quantity in intensely sericitized rock and as a rule is closely associated with coarse gold. This metasomatic tourmaline is believed to have resulted from the solution and redeposition of the detrital tourmaline which is fairly common in the banket. The introduction of the great quantity of sulphur thus admitted by the placer protagonists would seem to weaken seriously their argument, or suggest that part of the gold at least was conceivably brought in along with the sulphur. The data so objectively presented in the volume leave the impression that the evidence for either the placer or infiltration hypothesis is far from conclusive.

Microstructure of Silver Ores

F. N. Guild (*Econ. Geol.*, Vol. 12) presented the results of a ground-breaking study of the microstructure of the silver ores and their associated minerals. The paper was illustrated by a series of exceptionally fine photomicrographs of polished sections of silver ores. In the ores that he studied he found that there is an invariable order in which the minerals were deposited: (I) In silver ores carrying lead and zinc the order is (1) pyrite, (2) blende, (3) tetrahedrite, (4) galena, (5) ruby silver, polybasite, etc., (6) native silver; (II) in copper-silver ores the order is (1) pyrite, (2) chalcopyrite, (3) bornite, (4) chalcocite, stromeyerite, and argentite, (5) native silver; and (III) in silver-cobalt ores (1) smaltite, (2) niccolite, (3) argentite, (4) silver and bismuth. Tetrahedrite carrying silver as an isomorphous constituent is believed to be the chief source of silver in enriched ores. No criteria were found, however, whereby ores enriched by ascending solutions can be distinguished from those enriched by descending solutions. Professor Guild is inclined to believe that ascending solutions effected more enrichment than is generally recognized.

Microstructure of Magmatic Ores

Tolman and Rogers (Leland Stanford Jr. Univ., Publicat., 1916) carefully studied the microstructures of the magmatic sulphide ores, in conjunction with a study of the literature of the magmatic sulphide deposits. They found that the chief magmatic-ore minerals form in definite sequence; magnetite-ilmenite (an intergrowth), hematite, pyrrhotite, pentlandite, chalcopyrite, and bornite. Pyrite is claimed not to form magmatically. As the outcome of their studies they proposed the hypothesis that "the magmatic ores in general have been introduced at a late magmatic stage as the result of mineralizers and that the ore minerals replace the silicates." This replacement differs from that caused by pneumatolytic or by hydrothermal processes, however, in that neither quartz nor secondary silicates are formed with the ores. The distinction between magmatic ores thus defined and ores of pneumatolytic origin appears to be too tenuous for most critics. Graton and McLaughlin (*Econ Geol.*, Vol. 12, pp. 1-38) differed widely from the authors concerning the genesis of the copper deposit at Engels, Calif.; Bateman (*Econ. Geol.*, Vol. 12, pp. 391-426) dissented from their conclusions regarding the Sudbury nickel ores, finding that the ores show no evidence of replacement; and Coleman also (*Op. cit*, pp. 427-434) took issue with them concerning the Sudbury ores, his point of view being that field evidence outweighs laboratory evidence, and that the field evidence indicates that the deposits have segregated from the magma under the influence of gravity. Coleman's arguments, however, were directed mainly against the thesis maintained by C. W. Knight (Report, Royal Ontario Nickel Commission) that the Sudbury ores were deposited by hot circulating waters. Ries and Somers (Bull. 128, A. I. M. E.) dissented from the view that pyrite is not a magmatic mineral and brought evidence to show that certain Norwegian pyrite bodies were injected igneous masses.

Tungsten in Contact-Metamorphic Ores

The recent discovery and rapid development of the contact-metamorphic scheelite deposits near Bishop, in northwestern Inyo County, California, drew attention to a group of deposits not heretofore widely recognized as a possible source of tungsten (Bull. 640-L, U. S. Geol. Surv.). The ore consists of scheelite associated mainly with garnet, epidote, and quartz. Such ore resembles the contact-metamorphic rock common at many contacts of granite and limestone in the western states, but as it does not contain metallic minerals, such as magnetite, hematite, chalcopyrite, or pyrite, and as the scheelite closely resembles calcite, such ore is extremely likely to remain unrecognized. In fact in much contact-metamorphic tungsten ore the scheelite is so fine as not to be visible to the eye, but it can, of course, be readily detected by panning. In 1917 an unexpectedly large num-

ber of such deposits were found in Nevada, California, and Oregon; and, according to F. L. Hess,[1] who recently completed an inventory of the tungsten resources of the country, they will probably yield a large part of the tungsten output of the United States.

Oil and Gas Deposits

"Principles of Oil and Gas Production" is a valuable book by R. H. Johnson and L. G. Huntley. The title does not accurately indicate the contents of the book, which, as a matter of fact, describes not only the technology of oil and gas extraction, but also the geologic occurrence and origin of oil and gas; moreover, it gives a very condensed account of the oil fields and gas fields of North America. The treatment is in general brief but comprehensive; in places it is somewhat marred by careless writing and colloquialisms. Much new matter on the theory of oil and gas accumulation is given, emphasis being laid on a fuller consideration of the shape of the oil and gas reservoirs and on the texture of the reservoir rocks.

"Oil-Field Development and Petroleum Mining," by A. Beeby Thompson, is a work of considerably broader scope than the preceding. Despite the technologic nature of the title of this volume, five out of its 14 chapters are devoted to the geology of petroleum. The introductory chapter gives the geographical distribution of oil throughout the world, and outlines the history and production of the various oil fields. Succeeding chapters deal with the factors governing the formation, accumulation, and preservation of petroleum, with the surface indications of petroleum, with oil-field structures, and with the composition, characteristics, and origin of petroleum. Principles rather than detailed descriptions is the prevailing idea that has guided the author in his treatment of the subject. The book is excellently illustrated and interestingly written, and probably ranks as the best on the subject.

A. W. Lauer (*Econ. Geol.*, Vol. 12) made a detailed study of the petrology of oil-reservoir rocks and concludes that "induced openings," i. e., fractures, joints, etc., are more important than porosity in the accumulation of oil. This view is not wholly new, for J. P. Lesley more than 30 years ago wrote at length on the subject, but its significance and importance have since been possibly overlooked.

E. W. Shaw (*Science*, Vol. 46, pp. 553-556) put forward the interesting suggestion that concealed salt domes under the Louisiana-Texas coastal plain may perhaps be located by determination of gravity anomalies. As great pools of oil are associated with some of the salt domes, this method offers perhaps a new means of prospecting for these immensely valuable deposits.

Oil-Shale Investigations

The impending shortage of gasoline is evidently stimulating the study of oil shales in various parts of the world. H. R. J. Conacher (*Trans.*, 16, pt. 2, 1917, Geol. Soc. Glasgow), using an improved technique, made very thin sections of Scottish oil shales. He believes that these oil shales were formed in quiet estuarine mud flats, to which large quantities of finely macerated vegetable matter were brought by water flowing from swamps.

[1]Personal communication.

The oil shale in northwestern Colorado and adjacent parts of Utah and Wyoming was investigated by D. E. Winchester (Bull. 641-F, U. S. Geol. Surv.) in continuance of earlier work done by the Geological Survey. These shales are of fresh-water origin, of Eocene age, and are extremely rich in plant débris. It appears that in Colorado alone there is sufficient shale to yield 20 billion barrels of crude oil, and 300 million tons of ammonium sulphate. The content per ton in oil and ammonium salt compares favorably with that of the Scottish oil shale.

Estimation of Petroleum Reserves

The principles governing the estimation of petroleum reserves are discussed by R. W. Pack (Bull. 128, A. I. M. E.). After outlining some of the methods previously used in estimating the available supply of oil, he presented a new method which is particularly applicable to such fields as those of California. In brief, the method depends on the use of a curve that shows field production in unit time and has been modified to take into account the number of new wells required to drill the field completely.

G. S. Rogers (Bull. 653, U. S. Geol. Surv.) pointed out some significant features in the chemistry of the oil-field waters in San Joaquin Valley, Calif. Sulphates, which predominate in most of the shallow groundwaters, diminish as the oil-bearing zone is approached and finally disappear. Concurrently carbonates increase, though this change is largely influenced by the concentration of chlorides. The decrease of the sulphates and increase of carbonates as the oil-bearing zone is approached are attributed to reactions between the waters and the constituents of the oil and gas. These relations can therefore be made to serve as a guide in prospecting for oil and gas. In fact, E. A. Starke, of the Standard Oil Co has for several years "noted the absence of sulphates in waters associated with oil and ascribed it to chemical reaction between the two, and so has guided his prospecting to a considerable extent by studying the composition of the waters that are encountered in the prospect wells."

Coal Resources of the United States and the Production to Date

In recent years a large amount of detailed quantitative information has become available concerning the coal resources of the nation, and the present time seemed opportune to summarize this information. M. R. Campbell undertook this task and wrote an introduction to a report ("Coal Fields of the United States," Professional Paper 100-A, U. S. Geol. Surv.) that is to sum up existing knowledge regarding the extent and quality of the coal of the United States. The present installment described briefly the various fields, and the succeeding installments, which are being written by the specialists best acquainted with those fields, will give the details concerning the coal resources of the country. Campbell now estimates that the original tonnage of coal in the United States within 3000 ft. of the surface aggregated 3,538,554 million tons—a considerable increase over his earlier estimate. The total production to the end of 1914 is computed to be approximately 10,358 million tons, which is estimated to mean an exhaustion of 15,083 million tons.

Gold Dredging in 1917

By F. F. SHARPLESS*

OTHERWISE than in some mechanical details, gold dredging made little progress in 1917. There were but few new installations, owing partly to the reluctance of operators to venture into any new projects under the present adverse and uncertain conditions. These adverse conditions are, in the main, the high cost of labor and its scarcity, and the high cost of all material, thus making the expense of dredge installation excessive. To these must be added other uncertain factors, such as the constantly diminishing purchasing power of the metal to be recovered, heavy taxation and the possibility of gold production being regarded by the Government as a non-essential industry. The foregoing obstacles apply not only to new plants, but they were felt by dredging enterprises already in operation, preventing their expansion. Foreign dredging enterprises felt the hardship of the present conditions more than those in the United States, since it was quite impossible to have dredges built in foreign countries, or even to secure repairs for those already installed, on account of the demand for war materials taking precedence over all other requirements.

Few Failures in Properly Prospected Ground

While the obstacles referred to undoubtedly interfered with dredging enterprises, they had a beneficial effect in causing managements to search for and introduce every possible new economy. This is not now an easy task, for each year, of late, has found gold dredging established on a more businesslike and scientific basis, and recently there have been fewer failures due to the lack of application of these principles. Careful and systematic prospecting by competent engineers has done much to prevent unwarranted dredging installations, and on the other hand, this accurate and reliable prospecting, together with some improvements in the art of gold dredging, has induced a few companies to install dredges on ground that had not heretofore been considered profitable for dredging.

Late improvements have consisted in better design of details and better material and workmanship, rather than in any one important modification. The principle of carefully designing each and every dredge to fit the particular and special conditions under which it is to operate has accomplished much toward success. In the California fields, the problem of resoiling is gradually being worked out by the use of multiple stackers. The unique distribution of tailings and the making of a new channel in the Yuba River have been accomplished by the construction of extraordinarily long stackers placed athwartship. This method is in successful operation[1] in the Yuba River. Some work is still being done with jigs on dredges in California. The result of the installation on the Yosemite dredge, at Snelling, Calif., shows[2] a total recovery of $3786 during 22½ months' operations. It will be noted that this amounts to only $168 a month, and it is a question whether this saving was not offset by a greater cost, considering the amount of apparatus needed, the cost of repairs and attendance required by the apparatus, and the possibility of a somewhat reduced yardage of the dredge itself. There may be a few instances where the loss of precious metals on a gold dredge will warrant the installation of a simple form of jig, but it is probable that these instances are not as many as is generally supposed, especially if the dredge is well designed in the beginning and has ample table area. Little was recorded of accomplishment in 1917 that would encourage or warrant general installation of jigs, especially where the jigs are belt driven and have many movable and wearing parts. There has been recently developed a pneumatically pulsated jig which has no mechanical movable parts, and it would seem to be ideal for dredging work, but the positive need for something of this character must be more fully proved before anyone can expect the ideal type of dredge jig to appear.

Simplifying the Main Drive

The main driving apparatus of the present dredge is susceptible to considerable improvement. The great, heavy, cumbersome double gears now used on each side of the tumbler may eventually be replaced by a drive on one side of the tumbler, consisting of a much smaller gear driven by a herringbone set, operating in an entirely self-contained and enclosed automatically lubricated steel housing. This will result in at least 20% saving in power, a reduction in weight and first cost, and will afford unlimited space for greater depth to the dump hopper. This arrangement will also reduce the liability of misalignment of all bearings. It would appear that the complicated operating levers and clutches now in general use might readily be replaced by a system that is pneumatically operated. In fact, such a system has already been devised, and experiments up to the present would seem to prove its value.

Dredging Results in the United States

Dredging in California was carried on in 1917 with the usual success. The Yuba company put its Yuba No. 16 dredge in operation early in the year, while Yuba No. 17 was launched Nov. 4. The Conrey Placer Co., in Montana, operated successfully in 1917, and there was no new construction undertaken in that state. A small dredge, formerly situated at Castle Creek, N. D., built some years ago, was knocked down and moved into Oregon, but it is understood that it has not accomplished anything more at its new site than it did in its former place, principally on account of low returns, and this, in both instances, was probably owing to the lack of careful prospecting. The two dredges on the Powder River in Idaho were reported to have had a successful season.

In Colorado, an old dredge was moved from California and is now in course of reërection at Breckenridge. The Tonopah Placers Co.'s three dredges at Breckenridge also had a good season. Their cleanups were held up to about the usual yields. The French Gulch dredge operated steadily and successfully under the management of

*Consulting mining engineer, 52 Broadway, New York.

[1] "Eng. and Min. Journ.," Dec. 1, 1917.

[2] "Min. and Sci. Press," Dec. 8, 1917.

Warren F. Sears, and the usual high recoveries were maintained throughout 1917. The Derry Ranch Gold Dredging Co.'s dredge, at Leadville, remains the only installation in that section of the country. Under the management of Robert F. Lafferty it had a most successful season, recovering $111,084. Operating expenses in the Leadville district were high, but nevertheless profits were large, and the company continued the distribution of unusually large dividends.

Results of Alaskan and Yukon Operations

The dredges in Alaska and Yukon Territory did not contribute much in dividends to their stockholders in 1917. The Canadian Klondike Mining Co.'s fleet of four dredges below Dawson, Y. T., were operating all season, but their recoveries were low and the operating costs high, which resulted in placing the company in financial difficulties.

The Yukon Gold Co. operated steadily in the Yukon district in 1917, and its dredge on the Iditarod in Alaska continued in good ground with exceptionally high yield. The company installed a new all-steel dredge at Murray, Idaho, having 7½-cu.ft. buckets, electrically driven. This dredge started into successful operation early in December. The company moved one of the old 7½-ft. dredges from the middle fork of the American River in California to the north fork; it is expected this will be completed and put in operation in the near future. Its large all-steel dredge, that was originally placed at the head of Coffee Creek in Trinity County, California, was dismantled and moved to the lower end of the creek, numerous difficulties in the original plans having made this step necessary. This dredge started up early in December, 1917, in its new situation, and has every promise of a successful future.

At Nome a number of small dredges were operating as usual, but few recorded any dividend disbursements. The Alaska Mines Corporation floated some stock on the Eastern market and an attempt was made to expand its operations, but the efforts did not meet with great success. High cost of fuel and labor mitigated against profitable dredging operations during 1917 in Alaska.

South American Dredging

Dredging operations in British Guiana were conducted in 1917, along about the same lines as heretofore, with no new installations. In fact, there was no new dredging installation in all South America. In Colombia, the General Development Co. has a 6-cu.ft. Bucyrus, oil, electric-driven dredge en route to Buenaventura, and it is expected that this will be transported and erected at an early date. This company had a dredge of foreign make on its property, which was put in about four or five years ago, but it has not been operated steadily on account of many local difficulties. The Pato and Nechi dredges at Zaragoza, Colombia, had a successful year, and the recoveries from the ground worked maintained a high average. While the latter company felt the heavy hand of excess-war taxes in England, both dredges kept up a large production throughout 1917, under the general direction of W. A. Prichard. A small, Dutch-built dredge belonging to the Antioquia Dredging Co., was operated on a tributary of the Magdalena River, by Clarence J. London. The steam equipment was taken off the dredge and oil engines were substituted; it was also equipped with a belt stacker instead of the former pan type of stacker. These improvements enabled the dredge to show an operating profit.

In Australia there are about 40 dredges operating, and while these make some profit the total dividends from all 40 dredges were exceeded by the earnings of one single dredge in the United States. Practically the same situation exists in New Zealand. In Portuguese East Africa, the Andrada company was operating a Bucyrus all-steel dredge; while this company had difficulty with boulders at the inception of digging, it was reported that all obstacles were overcome, and that operations were being successfully conducted.

Gold dredging in the Philippines was not marked by new installations in 1917. Three or four foreign-built dredges were operating, but it is believed their earnings were not great. The old Gumaos company's Empire dredge, which operated for five years and worked out its ground, was transferred to a new company called the Malagno Placer Co., and is being moved to the Malaguit River, where the company has ground that it is supposed can be worked at a profit.

Mambulao's Dredge Successful in the Philippines

The Mambulao company's Empire dredge, which was installed by the New York Engineering Co., had its second year of successful operation. This dredge is a departure from the usual standard dredge. It has its own steam-electric generating plant on board, consisting of a steam turbine, direct connected to a 500-kw. electric generator, which serves to operate all electric motors of the different units. This rendered the dredge highly efficient, especially in fuel consumption. It is the first gold dredge to be equipped in this manner.

Another unusual feature of this dredge is a clay sluice mounted over the top of the screen. This is for the purpose of taking care of about 45 ft. of barren clay and muck overburden, the enriched gravel deposit being about 10 ft. thick, underlying the overburden of clay. When digging the barren overburden, the buckets dump directly into the clay sluice, and all of the material is washed overboard about 40 ft. to the stern of the dredge. When the pay gravel is encountered, a gate is opened in the head section of the sluice, the gravel dumps into the main hopper, passes through the screen and over the gold tables in the usual manner.

The Mambulao was the first dredge to be built with one-piece, all-manganese steel buckets. While this type of bucket is not adapted to digging indurated or cemented gravel, it has proved highly successful and efficient under the operating conditions for which it was designed. The bucket line has been in operation two years; its present condition shows an equal wear on all parts of the bucket, and the indications are that when the lip portion is worn out the back of the bucket will also be gone, so that the whole bucket may be scrapped at the same time. The special design of this dredge has enabled it to handle a difficult piece of ground, and proves the value of designing each dredge to fit the particular conditions under which it is to operate.

Gold dredging in Russia was on the verge of making considerable advance, but the recent political disturbances not only interfered with this but set the country's

mining activities back many years. The Bucyrus company is building a 17-cu.ft., all-steel dredge, which is ultimately to be installed on the Lena Goldfields property, but present conditions are not favorable for either shipment or installation of this dredge. Another dredge, having 7½-cu.ft. buckets, was also contracted for by the Czar's Cabinet, but the fate of this dredge is uncertain. The Orsk Goldfields operated with success both of its dredges throughout 1917. These dredges were situated about 50 miles from Nikolaievsk, near the eastern coast of Siberia. They operate under difficult physical conditions, owing to their remoteness from any base of supplies. However, high gold content of the gravel and the efficiency of the plant enabled the company to make satisfactory earnings.

New Dredging Field in Chosen

The one new field of gold dredging that opened with a promising outlook in 1917 was in Chosen. The Chiksan Mining Co. contracted with the New York Engineering Co. for a 10-ft., all-steel, electrically driven dredge. This was erected and went into successful operation on Dec. 1, 1917. The dredge contains some unusual features, which were designed to meet certain specific conditions. The Chiksan's deposit consists of a barren overburden of clay, sand and muck, with pay gravel underlying. It was necessary to conserve the water, therefore the following new design was adopted: The revolving screen has spiral-shaped manganese deflecting bars running throughout its entire length, arranged similarly to the rifling in a gun barrel. When the barren overburden is to be dug, the screen is revolved in a direction so that the spiral manganese bars assist in rapidly advancing the material through the length of the screen to the discharge end, all water being shut off from the interior of the screen. An ample supply of water is led into the bottom of the screen housing, in order to wash any material over the tables that may pass through the perforations of the screen. The discharged barren material from the end of the screen is deposited either on a stacker, or a deflecting gate turns it into a chute where it may be deposited close to the stern of the dredge in order to afford a foothold for the spuds if necessary. When pay gravel is encountered water is turned into the screen, and the screen is rotated in the opposite direction, the spiral bars then tending to retard the movement of the gravel so that it is thoroughly washed as it is passed through the screen. This gravel, when it reaches the end of the screen, may either be dumped on the regular elevator conveyor belt or into the tail chute. The foregoing arrangement is working most satisfactorily, and by its use it is possible to resoil the land if that should prove to be necessary or advisable. The Chiksan company has large placer holdings, and it is probable that another dredge will be installed as soon as conditions in the United States are more favorable for dredge construction and the ocean-freight situation makes deliveries possible.

There is little prospect that many gold dredges will be installed in this country, or in fact in any country, while the war lasts and present labor and material scarcity exists.

Metallurgy of Quicksilver

By MURRAY INNES*

THE outbreak of the war found the California quicksilver industry on its last legs. The United States production had been steadily declining for about 40 years and in 1914 the output of about 30 mines was estimated at 16,500 flasks, having a gross value of $812,000. California's share of this production was 11,300 flasks, of which 6550 flasks were produced by the New Idria mine at a net loss for the year of $45,000. This gradual death of a once important industry was due to inability to compete with the European output having lower labor costs. The industry had few votes and scant Government consideration or protection.

Average Yield from California Ores Only About 6 Lb. per Ton

After about three years of war it is now realized that a supply of this metal is a desirable thing to have in the country; that production has not kept pace with the consumption, and, further, that the present United States supply is small. I am informed that there is little or no quicksilver in New York or San Francisco and only a moderate amount in transit, and were it not that certain of the larger producers, appreciating the needs of our Government, refused to advance prices under stress of war demands, the present market price would be much higher. On the other hand, the ores of California are now of extremely low grade, the average recovery being about 6 lb. of metal per ton, and increasing costs of all sorts have, in some cases, doubled the first cost of the metal.

In view of these facts, a better understanding of the metallurgy of quicksilver becomes increasingly important. The business had become so small and unattractive that our metallurgists and chemists deserted it for more promising fields, and engineers qualified by training and practical experience to handle quicksilver mines and plants were rare indeed. In March, 1917, I took up with Dr. L. H. Duschak, chemical engineer for the U. S. Bureau of Mines in California, the question of a thorough investigation of the stack and fume losses in Scott furnace operation, and in the following month Dr. Duschak was authorized by the Director of the Bureau to coöperate in this matter with such of the mines as would share the expense. Since then this research work has been in progress and considerable valuable data are about ready for publication by the Bureau.

Stack Losses from Scott Furnace Practically Nil

Many small problems were solved, including methods for the accurate determination of mercury in furnace gases, methods for determining the volume of these gases and their sampling over an extended period, etc. Perhaps the most surprising result obtained was the

*Mining engineer, 217 Kohl Bldg., San Francisco, Calif.

demonstration of the fact that the stack and fume losses of a Scott furnace, when properly operated, are practically nil. Many quicksilver mines that started in past years with great expectations proved disappointing, and the usual explanation was "unaccountable losses of metal." The research work under the supervision of Dr. Duschak at the New Idria and Oceanic plants showed stack and fume losses of but a few pounds per day, and it would seem that the condensation problem was practically solved. Considerable loss sometimes occurs due to imperfect roasting of the ore, but this is usually due to carelessness and is therefore readily recognized and remedied.

Inadequate Sampling Responsible for Many Failures

The lack of proper sampling facilities and methods was the cause of many of the disappointments. Overestimation of the tonnage roasted and its assay value and insufficient allowance for moisture also played a part. In general, recent work showed that the disadvantages of the Scott furnace, due to rather high first cost and moderate capacity, are more than balanced by its simplicity and durability, its low fuel costs and general efficiency. Another point in favor of the Scott furnace is that the ore is only crushed to pass a 2 or 2½ in. and, therefore, the fine grinding evil is avoided. The Scott roasting furnace continues to produce about 95% of the output of the state, and when rightly handled has proved to be a most efficient and economical roasting device.

On the other hand, it is apparent that a loss by concentration of 1 lb. of mercury per ton of ore will more than balance the entire cost of roasting. Concentration is, therefore, seldom worth consideration, but may occasionally prove useful for the treatment of old dumps, etc., where a small investment is the main consideration, it being apparent that any quicksilver ore that will yield a profit by concentration will be still more profitable if properly roasted.

The new rotary furnace of the cement-kiln type, now being installed by the New Idria company, is something of an experiment, but has greater possibilities of being (as compared with any wet method) an advance in the matter of increased tonnage and decreased costs. This rotary type of furnace has been tried before, but probably never under such favorable circumstances or in such able hands. The thanks of the quicksilver miners are due the Idria management and Dr. Duschak for efficient investigations and research, looking toward the general benefit of conditions in the quicksilver industry of the future.

Magnesite in 1917

THE production of magnesite in the United States in 1917 was probably double the 1916 output, which was 154,000 short tons. The great increase in production since 1913, in which year only 9632 short tons were mined, was due to the cutting off of Austrian supplies because of the war. California and Washington produced the bulk of the magnesite mined in the United States. The gain in output in 1917 over that in 1916 was largely due to the working of deposits in Stevens County, Washington, shipments from which state began in December, 1916. California, which in 1916 was practically the only producer, gained somewhat in 1917. About one-half of its output came from the vicinity of Porterville, in Tulare County. The chief American producers were the Porterville Magnesite Co., in California, and the Northwest Magnesite Co., in Washington. Other companies in the new Washington field were the U. S. Magnesite Corporation, the American Mineral Production Co. and the Valley Magnesite Company.

Bad Weather and Transportation Conditions Limited Canadian Output

Magnesite mining in Quebec in 1917 was retarded by rainy conditions, the work being done in openpits. The magnesite had to be hauled several miles over heavy clay roads in some parts. Nevertheless, shipments averaged five cars per day. In 1916, Canada shipped 55,413 tons of magnesite mostly from Grenville Township. The North American Magnesite Co. and the Scottish Canadian Magnesite Co., the principal operators, began in 1917 to make dead-burned magnesite containing a suitable per cent. of iron for furnace lining. This was done in the cement kilns of the Canada Cement Co. at Longue Point, near Montreal, and at Hull, near Ottawa. The North American company also leased property in Harrington Township, where it mined magnesite and stored it for hauling on winter roads.

The Mansallo and La Plata magnesite quarries, near Puerto Viejo, Island of Margarita, Venezuela, were worked during 1917, producing about 10 tons of magnesite per day. Exports to New York was rendered difficult by lack of ships. Freight charges on such ships as were available were $19.50 per ton of magnesite against a quoted price of the mineral of only $25 per ton. An economic survey of the magnesite deposits on the island was being made.

Shipping Conditions Restrict Imports

Imports in 1917 were greatly restricted through lack of ships. In 1916, the United States received from Greece 60,511 tons of crude and 9514 tons of calcined magnesite. During 1917, California crude magnesite, 90% $MgCO_3$, brought about $10 per ton, f.o.b. shipping point, against $8 for Washington crude. California calcined averaged about $40 for 85% MgO, Washington calcined bringing about $35, f.o.b. shipping point. The better prices for California magnesite were due to its superior color. The freight to Atlantic seaboard was $12.50 per ton.

Magnesite is used chiefly for furnace linings, pipe coverings, and the manufacture of CO_2, magnesite cement, outside stucco, passenger-car floors, gun-emplacements, etc. The American Firebrick Co., of Spokane, Wash., began the manufacture in 1917 of magnesite brick. According to the opinion of some in the refractory trade, as good a product for refractory purposes can be made from the domestic magnesite as from the Austrian variety.

General Review of Mining in the United States in 1917

MININC conditions in the United States in the early part of 1917 were exceedingly favorable, and the largest copper, lead and zinc producers of the country were forcing their plants to the utmost. The entrance of the United States into the war and the unsettled market conditions, labor and car shortages that ensued had an adverse effect on production and the general gain for the first part of 1917 was more than offset by the months of non-productiveness that occurred in many of the largest districts during the period of labor agitation and strikes that spread over the country, and the general retrenchment that followed. The effect of increased wages throughout the country was a decrease in efficiency. The draft and response to the call for volunteers reduced the available labor supply materially in all but a few favored districts. The gold camps suffered from increase in cost of supplies without commensurate advance in price of marketable product, and were obliged to raise wages to meet the high cost of living and the drain put upon the labor supply by the attraction of the higher wage base-metal districts. The effect of the Government agreed price for copper at 23½c. was to eliminate from the field many small producers which curtailed the total production possible from all sources in this country.

The curtailment of imports of pyrite, manganese, magnesite, potash, graphite, clays, etc., caused domestic resources to be investigated and developed to an extent hitherto impracticable and in some instances with considerable financial success. The general high cost of labor and supplies in 1917, and the uncertain demand, the embargoes and price regulations of the future, however, discouraged the exploration and development of many new and large mining enterprises.

ARIZONA

The copper production of Arizona for 1917 is reviewed elsewhere in this issue. The main producing districts, Ray, Inspiration, Miami, Bisbee, Morenci, Jerome, and Globe, maintained a high output early in 1917, but suffered heavy loss of production during the labor strikes of June, July and August, and the Inspiration did not resume full operation during the latter part of the year. The Ajo district was added to the list of copper producers, and a number of small shippers in the state contributed to the total output. The Bisbee-Warren district was also a producer of zinc-lead and silver-lead ores, and also shipped manganese and pyrite. Arizona-Hercules carried on considerable development work at Ray upon completion of the churn-drilling campaign early in 1917; the 1200-ton concentrator and power plant at Kelvin were about half completed in December.

Silver-lead ores from the Ray district were shipped by the Ray Lead Development Co., and the Broken Hills Mining Co. was under development. A vanadium and molybdenum strike occurred near Kelvin. The Mammoth Development Co. suffered a setback in production in October due to a shaft fire, which made it impossible to fulfill its contract to supply 50 tons of wulfenite concentrates per month; the mill was remodeled, and the entire plant reorganized for greater output. The Arizona Rare Metals Co.'s mill continued to operate on the old Mammoth tailings, shipping wulfenite concentrates steadily to its furnace in Tucson, where a sodium-molybdate slag and a lead bullion were produced. At Copper Creek new equipment was added to the mill and power plant and flotation introduced. The Lavell gold mine, near Chilito, was bonded to Boston interests in 1917, development undertaken and high-grade gold shipments made.

The Oatman district established a minimum wage of $4 a day, and did not suffer for want of a sufficient supply of labor, nor was it affected by the labor disturbances of 1917. In January the United Eastern started its new mill and the company treated about 85,000 tons of $22 ore during the year. It also acquired two important claims from the Big Jim company, where ore had been opened up. Considerable new ore was found by the various operators in the district, including the Gold Road mine at Goldroad. Marked activity was manifested at Chloride, Golconda, and outside of Kingman. At Stoddard the Arizona-Binghamton Copper Co. was organized to take over the Stoddard and other properties; new ore was opened up from the lower levels, and 300,000 lb. of copper per month shipped as concentrates. Developments of note occurred east of Congress Junction, where gold, silver and lead shipments were made. Quicksilver was discovered and shipped from the Phœnix Mountains, and important development took place at Courtland, Johnson, Harqua Hala, Duquesne, Silver Bell, Twin Buttes, Tombstone, Pearce, and Dos Cabezas.

CALIFORNIA

In Amador County the mines of the Mother Lode at Sutter Creek, Plymouth and Jackson operated under a severe labor shortage and increased costs. The Plymouth Consolidated added two Hardinge mills to its plant and handled 11,000 tons of ore per month. The Keystone operated its 40-stamp mill to capacity, hoisting ore from between the 900 and 1800 levels. The Central and Old Eureka mines attained greater depth and developed new ore. The Kennedy's 100-stamp mill operated steadily in 1917 and new ore was developed at 3900 ft. The South Eureka hoisted a considerable tonnage from the deep levels of the Oneida. The Argonaut completed its equipment for electric pumping in two stages from the 4800 level, and good-grade ore was hoisted.

California oil production in 1917 was highly stimulated and a great increase over 1916 will probably be recorded. Tungsten production was active at Atolia and Bishop. Potash was produced from Searles Lake deposits, from kelp and from the flue dust of various cement plants. Additions to the plants of the Standard Oil and General Petroleum companies were made and working forces increased to maximum. A new refinery was started late in 1917 at Los Angeles harbor by the Union Oil Co. The iron-ore deposits of Southern California attracted considerable interest.

In Plumas County the Jamison mine because of scarcity of labor operated with half the normal crew, and finally closed down for the winter. In the Nelson Creek district the Bulkeley Wells syndicate bonded the Morning Star, a Tertiary gravel deposit of considerable magnitude. The Standard Mining Co. had an eight weeks' run. The Plumas-Eureka Corporation in December started a 1115-ft. raise to connect the "76" mine and the Eureka tunnel.

Owing to inadequate transportation, activity in Del Norte County was handicapped but promising bodies of chrome ore were uncovered and considerable chromite was shipped.

The Natomas Co. operated 11 electric dredges on the American and Yuba River fields. In the Yuba Basin Yuba Consolidated started the first double-stacker dredge. In Shasta County, miners received an increase in wages early in 1917. The Mammoth, Balaklala and Mountain copper mines suspended production for a short time in the summer on account of labor troubles, but operations were resumed in September. In Butte County near Yankee Hill a 20-ft. gold-bearing vein was disclosed near the Surcease. In Siskiyou County the Blue Ledge copper district became more active, machinery was purchased and some rich copper and gold ores were shipped to the smeltery at Tacoma. In San Luis Obispo County quicksilver and chrome deposits received attention. In Sierra County purchase of the Tightner gold mine was made complete by a final payment.

Colorado, Idaho and Utah

The mining activities in Colorado, Idaho and Utah will be reviewed in detail in a succeeding issue of the *Journal*, and will be referred to only briefly at present. In Colorado the isolated districts experienced during the summer months an activity not felt for many years. Many silver properties were reopened, the demand for tungsten was steady and the market for manganiferous ores increased shipments from Leadville to such an extent that at the end of 1917 750 tons per day of such ore was being sent to the Colorado Fuel and Iron Co. and other metallurgical works. In Idaho, the new Bunker Hill & Sullivan lead smeltery at Kellogg was blown in, and three important cases of litigation came before the courts. The diverse metal production of Utah showed a slight increase in 1917 over that of 1916. Smelting difficulties curtailed shipments in the last half of the year, but the important districts of Bingham, Tintic and Park City operated for the most part steadily.

Michigan, Minnesota and Wisconsin

A review of iron mining appears elsewhere in the iron section of this issue. The copper operations in the upper Michigan peninsula are also separately discussed by James MacNaughton. Iron-ore shipments on the lakes began in the middle of April, but navigation was not fully opened to Duluth and Superior until May 1; the lake shipping season, however, continued a little later than usual, not closing until about Dec. 11, 1917. In the southern section of the Cuyuna iron range, in Minnesota, considerable prospecting was done by drilling, and results were satisfactory. In the Wisconsin zinc-lead district new mills and development by drilling and sinking continued in 1917.

Missouri, Oklahoma and Kansas

The Southeast Missouri lead and the Joplin zinc districts are covered elsewhere in this issue. At Fredericktown the Missouri Cobalt Co., Ltd., remodeled its reduction plant for the treatment of its complex lead, nickel, cobalt and copper ores, and Missouri Metals Corporation began the exploitation of the old Mine La Motte—by steam shovel for the surface carbonate ores and by underground methods for the sulphide ores of lead, nickel, cobalt, copper and silver. As in 1916, the Joplin-Miami district suffered from lack of sufficient electric power, due to low water at the hydroelectric and poor equipment at the steam-turbine plants of the district power company.

In the Oklahoma-Kansas section repeated ore strikes by drilling were made in 1917 in all parts of the district. Leases were taken at high premiums and increased royalties paid. Baxter Springs, Kan., became a center between Joplin and Picher and the other camps in the Miami district, and railroad connections were completed from Galena to Baxter, Kan., and to Picher, Okla., and also a line between Quapaw and Century, Okla. Considerable high-grade ore was found by drilling around Baxter. The Eagle-Picher Lead Co. operated actively with four mills, making a large production of zinc concentrates; flotation was added at its Netta mill. In the Kansas zinc field a large tract, north of the Eagle Picher holdings and west of Baxter Springs, was taken under development by the Miami Zinc Syndicate, in which American Metal Co. eventually became the predominant interest; this company also took over a 1000-acre lease northwest of Picher. The Metals Exploration Co. made extensive purchases and the Admiralty Zinc Co. sold its leases and three mills to Cosden, Aiken & Curtis of Tulsa, Okla. In addition a large number of smaller deals were consummated in 1917. Twelve new mills were started early in the year and a large number started in 1916 were completed in 1917. Although 50% of the electric power was off in the latter part of the year, the production of the newer field equalled the old. Churn drilling was never more active than in 1917, several thousand rigs covering all that region from Joplin to Miami and extending westward from Baxter, Picher and Commerce. Developments in 1917 demonstrated the great possibilities in this newer area, and an increasing production may be expected. Manganese mining in northern Arkansas was stimulated by the high prices and marketability of low-grade manganese ores, and in 1917 a considerably increased production was made.

Montana

Montana produced in 1917 at a record rate until the labor strikes at Butte in June; copper production of this district did not again approach the normal figures until the last quarter of the year. The Butte district is reviewed elsewhere in more detail by Mr. Thayer. A notable event of 1917 was the organization of Montana mining interests to protect the industry from malicious legislation. A new feature of the Butte district was the production of manganese ores. This ore was also produced in the Philipsburg district in Granite County where an important output was being made at the close of 1917. In the Virginia City gold district

operations were limited. The Eastern Pacific cyanidation mill worked on tailings from the old Easton mine, and a new five-stamp amalgamation and concentration mill operated in Williams Gulch on ore from the Mountain Chief and Mountain Flower claims. A 20-ton test mill at the Winnetka mine was built, and there was a discovery of high-grade gold ore in Barton Gulch from from which shipments were made. The Rough Rider tunnel was extended 600 ft. in the Summit district.

The Boston & Montana Development Co. continued the prospecting of its properties in the Elkhorn district and began the erection of a 500-ton mill. In the Sheridan region there was increased activity in lead-silver properties. In the Twin Bridges section electric-power lines were extended to the Bielenberg & Higgins mine in Bear Gulch and to the Lake Shore mine. The Crystal Lake Gold Mining Co. purchased the N. J. Trauffler mine; the Liberty Gold Mining Co. purchased the M. R. Ostronich property. In the Pony district quiet prevailed, the only production coming from small leasers. In the Red Bluff area the only events of note were the sales of the Birdie and Red Bluff properties and the purchase of machinery for development. In the Richmond Flat district the Revenue mine operated continuously, and new ore was developed. The Madison mine was purchased and preparations were made to unwater. The Missouri mine, at the head of Meadow Creek, made regular shipments of high-grade ore and erected a mill. In the Madison Valley prospecting was active and the results were encouraging. Asbestos deposits were discovered southeast of Lyon. The manganese deposits of Cherry Creek were mined and explored during the summer and regular shipments made, but production suspended on the advent of winter.

Nevada

In Nevada, the Nevada Consolidated's new crushing plant was completed in two sections each having a capacity of 750 tons of grizzlied ore per hour. A new Nordberg hoist was installed and the coal-dust plant was nearly completed. Development at the Ruth mine for a branch raise system of mining was continued and one portion of the mine was drawn to completion, yielding an estimated recovery of 97.8% of the orebody of a grade that averaged 2.07% copper. The Consolidated Coppermines Co. at Kimberly was financed, considerable development performed and a 1000-ton flotation mill completed.

At Tonopah production of silver ore was maintained at a high rate. The cyanidation plant at Millers was dismantled and installed in Tonopah and new ore was developed in many of the subsidiary properties in the district. Manhattan experienced a year of renewed activities through discoveries at the White Caps mine, and metallurgical study resulted in the installation of milling equipment. Goldfield Consolidated continued to produce and a modified leasing system was put into effect Feb. 1. New ore was uncovered in the Aurora Consolidated at Aurora.

Discoveries and shipments of good-grade silver ore were made from virgin deep workings on the Comstock Lode, where pumping lowered the water below the 3000 ft. level. The Jarbidge district attracted attention by the advent of new interests and new development.

In the Searchlight district the Quartette and Duplex mines shipped gold, copper and lead ores. A high-grade gold milling ore was produced by the Chief of the Hills Gold Mining Co., and the Big Casino developed low-grade ore, Clark County shipped zinc, lead, copper and gold-platinum ores and also developed manganese ore in 1917. Gold discoveries were made in the El Dorado Canyon district, where several mills were in operation.

At Tuscarora the Holden Mining and Milling Co. leased and purchased adjacent properties, and began the erection of a mill. The Delker, 20 miles west of Currie, shipped 10 cars of copper ore.

The Western Ore Purchasing Co., at Hazen, increased its capacity to 900 tons. The Mason Valley copper smeltery at Thompson resumed operations on Feb. 13, again affording an outlet for the Yerington district ores. The Nevada Douglas and Bluestone maintained steady shipments to the smeltery. At Rochester, the Nevada Packard Co. increased mill capacity to 100 tons. At Mill City the Sutter produced 30 tons of tungsten ore per day. A number of properties in Humboldt County increased production, and at National development was active. In Lander County the Nevada Austin Mining Co. constructed a mill.

The Nevada United Co. was leased by outside interests. In December 50 tons of ore per day was shipped from Aurum. Copper, gold and silver ore was shipped from the Lucky Deposit groups. Lead was shipped from a discovery in the Quake Range. A five-stamp mill was started at Willow Creek. The U. S. Tungsten Co. ceased operations.

Pioche shipped 150,000 tons in 1917. The Davidson Mining Co. was launched and the Amalgamated-Pioche plant closed.

New Jersey and New York

The New Jersey Zinc Co. at Franklin Furnace, N. J., suffered somewhat from labor shortage. Transportation difficulties, however, were not so serious as in other parts of the country, shipments being made continuously in solid trains that plied between the company's mines and reduction works. In New York at Edwards the Northern Ore Co. mined zinc-pyrite ore in 1917. The St. Nicholas Zinc Co., at Summitville, built a mill but later ceased to operate it. At Graham, the New York Zinc Co. planned to develop a similar area between Port Jervis and Summitville. The graphite output near Ticonderoga was doubled. The St. Lawrence County talc mines and the iron mines in the Lake Champlain district produced at maximum capacity.

New Mexico

In Grant County, the Chino Copper Co., the most important operation in New Mexico, maintained its normal output in 1917. The Burro Mountain Copper Co. at Tyrone produced steadily at the rate of 40,000 tons per month; development was favorable and at the company's mill improvements in the application of the flotation process were made. The Austin-Amazon opened a wide body of copper ore on the 770-ft. level. At Steeplerock the Carlisle mine reopened to the 750-ft. level, completed its mill, and several other interests entered the district. Pinos Altos, Fierro and Hanover camps all experienced renewed activity, and the Hanover-Bessemer Steel and Iron Co. completed its 400-ton mill at Fierro.

The Lordsburg district production was materially increased. The largest producers were the 85 Mining Co., the Lawrence, and the Nellie Bly. The "85" company started a new concentrator of 500 tons capacity. The Lawrence Mining Co., a subsidiary of the San Toy, purchased the Bonney mine from the Western Mining and Development Co. The South Chino Copper Co. purchased the Atwood and the property of the Valedon Mining Co. The Tyndale Copper Co. also purchased a number of claim groups in the vicinity of the Bonney. The Last Chance silver mine, at Leidendorf, near Lordsburg, was taken under lease and bond by local interests. In Dona Ana County the Phelps Dodge developments in the Organ Mountain were curtailed on account of war conditions. The Senorito Copper Corporation at Senorito, in Sandoval County, contracted for a Greenawalt leaching and electrolytic plant, but owing to delayed deliveries installed a 100-ton semi-fusion reducing furnace for the carbonate ores, and began work on a 60-ton reverberatory for high-grade chalcocite found in the sandstone.

In Socorro County the mines of the Kelly district produced steadily; lead, zinc and copper ores and concentrates were shipped by the Empire Zinc Co., the Ozark Smelting and Mining Co. and by leasers. In the Mogollon district of this county the usual activity of the precious-metal mines continued, Socorro Mines and the Mogollon Mines Co. being the leading producers; the former completed the tramway to the Pacific mine ores of which are now delivered directly to the Socorro mill.

South Dakota

In the Black Hills production of gold was maintained at normal in 1917 and the period witnessed the continuation of some important development work and the completion of new enterprises. The Homestake practically finished the second unit of the new hydro-electric plant on Spearfish Creek. Small shipments of tungsten ores went forward from Lawrence and Pennington counties. The Homestake's five-stamp mill produced tungsten concentrates regularly and shipped several carloads. The ore is ferberite and wolframite, and the concentrates contain 3 to 3.5% manganese with a little barite and scheelite but are free from tin or copper; a little gold is also recovered from this mill. The Elkhorn Tungsten Co., near Hill City, prepared its mill for tungsten ores. The American Tungsten Co. produced 3550 lb. of tin concentrates containing 50% metallic tin, but ceased operations during the summer. The Trojan company purchased the Two Johns mine and leased the Republic. The mill was increased to handle 500 tons and improved for higher extraction by finer grinding and slimes-plant additions. The Republic and Two Johns properties contain ore of milling grade, and with the Portland, Empire and Decorah, and considerable custom ore assured, a good supply for the future is provided.

J. T. Milliken of St. Louis, after diamond drilling the Oro Hondo, adjoining the Homestake on the south, purchased the property; he also took an option on the Montezuma and Wizzers mines, where prospecting by diamond drill was conducted with a view to developing pyritic ores. The Golden Reward company's 150-ton cyanide mill treated the company's gold ores from the Bald Mountain district the Astoria roaster was not operated, on account of fuel shortage. Mogul Mining Co. operated its mill steadily with a capacity of 100 tons per day. To work ore from the lower levels of the Mogul, Ofer and adjoining groups, a tunnel was started to prospect the ore zones of these properties. The New Puritan mine opened galena-bearing quartzite ore after considerable development. The Wasp No. 2 made a final shipment of tungsten ore, and was entirely abandoned and dismantled.

The Custer Peak Copper Co. completed a 10-stamp mill and produced native-copper concentrates from shale ore. The Spokane Lead and Silver Co. made one shipment of lead-silver ore and completed a 50-ton concentrator. At Galena some old properties were reopened and ores containing lead and silver shipped. Two cars were forwarded to Omaha from the Blue Lead copper mine. The Silver Queen shipped 14 cars of lead-silver ore. The Homelode company completed a 30-ton amalgamation-concentration mill. The U. S. Gypsum Co. completed a 100-ton plaster mill, in which operations started. The Dakota Plaster Co. erected a mill at Black Hawk. The Lithia mines at Keystone operated continuously and some ores were valuable for the phosphoric-acid content. Mica was shipped from Keystone, Hill City and Custer.

Oregon and Washington

The most noteworthy development in Oregon during 1917 was the discovery of new chromite deposits and their production; active search revealed bodies of ore in southwestern and eastern Oregon in Grant, Josephine, Douglas, Coos and Curry Counties, and 30 operators shipped. In the Homestead district, Baker County, the Iron Dyke gold-copper mine, a body of good-grade ore was opened and other old mines in this county were reopened. In the Waldo district, Josephine County, the Queen of Bronze, Waldo and Grayback copper mines and Simmons-Cameron-Logan hydraulic mine were sold. In Washington the development of the great magnesite deposits of Stevens County and the construction of calcining plants therefor were the most important events in the mining industry in 1917. At Northport, a Cottrell precipitation plant was added at the lead-smelting works of the Northport Smelting and Refining Company.

Tennessee and Other Southern States

Labor conditions in Tennessee were generally quiet in 1917. The copper companies in the Ducktown district operated as usual with but slight interruption. Coal lands changed hands in large tracts in the Cumberland-Plateau coal field. In Hancock County new zinc deposits were discovered and at one point preparations made for development. An event of interest was the discovery of manganese in Bradley County, near Cleveland. In Knox County there was a shortage of both white and black labor. At Mascot the table section of the zinc plant was almost doubled in size.

In Virginia prospecting for iron and manganese was active and several promising deposits were discovered; production was mainly from the Crimora and Powell's Fort mines. High barite prices created new interest in this mineral, and a number of old deposits were reopened. Iron blast furnaces that had been idle for years were repaired and blown in. The West End furnace, at Roanoke, was put into blast by John B. Guernsey & Co., who also repaired the furnace at

Graham; this was put in blast on spiegel, and in 1918 will produce ferromanganese. A number of furnaces formerly making foundary iron produced spiegel or ferromanganese. A noticeable effect of war conditions on blast furnaces in Virginia was that these were able to run more economically on Lake ores than on native limonite ores; on account of labor conditions, an adequate supply of limestone was hard to maintain. Virginia pyrite mines operated at capacity and in Georgia the Chestatee pyrite mine in Lumpkin County was brought into production. Shipments were made of sulphide ore from the dumps of the old Tallapoosa mine in Haralson County and underground development was in progress. In West Virginia the United Zinc Smelting Corporation's new works, at Moundsville, was completed; about 50 tons of sulphuric acid was being made per day and the toasted ore shipped to the Clarksburg plant.

Texas

In Texas the Presidio silver mine in the Shafter district continued to be the principal producer of silver. Small shipments of silver-copper ore were made from the Allamoore-Van Horn region, in Culberson County, and copper ore from deposits in the "Red Beds" in Foard and Hardeman Counties. The Freeport Sulphur Co., in Brazoria County, increased its output having placed a new "steaming plant" in commission. The sulphur deposits of Culberson County attracted considerable attention but the output was small in comparison with the coast property; a railroad for the district was projected. The Terlingua quicksilver district continued its record production, new properties being brought in as a result of the high prices. The old tin mine in the Franklin Mountains, 13 miles north of El Paso, was bought at receiver's sale by Mayor Charles Davis for $21,000. In Llano and Burnet Counties, graphite properties were under exploitation.

Alaska*

In 1917 Alaska produced minerals valued at $41,760,000 which, although about $6,870,000 less than in 1916, was greater than that of any other year. The most valuable mineral product was copper, of which 88,200,000 lb., valued at $24,000,000, was produced. This is less than the output of 1916, which was 119,600,000 lb., valued at $29,480,000. The reduction was due largely to labor troubles and is not necessarily permanent. The gold produced in 1917, $15,450,000, was also less than that produced in 1916, which was $17,240,000, and is the smallest since 1904. The reduction was due chiefly to curtailment of operations because of the scarcity of labor and the high cost of materials, but in part to the disaster at the Treadwell mine and the depletion of some of the richer placers. During the year Alaska also produced silver valued at $1,050,000, coal valued at $300,000, lead valued at $160,000, tin valued at $160,000, antimony valued at $40,000, and tungsten, chromium, petroleum, marble, gypsum, graphite, and platinum valued at $600,000. During 33 years of mining Alaska has produced more than $391,000,000 in gold, silver, copper, and other minerals. Of this amount, $293,000,000 represents the value of the gold and $88,200,000 that of the copper.

*Excerpts from advance sheets of the report of G. C. Martin for the U. S. Geological Survey.

The data in hand indicate that the value of the placer gold output in 1917 was $9,850,000; in 1916 it was $11,140,000. The decrease was due chiefly to restriction of operations because of the high cost of supplies and the scarcity of labor. The placer output was increased only in the Tolovana, Marshall and Ruby districts and at the new Tolstoi camp.

About 33 gold-lode mines were operated in 1917, compared with 29 in 1916. The lode gold mined decreased from $5,912,000 in 1916 to about $5,250,000 in 1917, due chiefly to the disaster at the Treadwell mine. Southeastern Alaska, especially the Juneau district, was still the only center of large quartz-mining development in the territory. Next in importance is the Willow Creek field. Gold-lode mining on Prince William Sound, Kenai Peninsula, and in the Fairbanks district was at a standstill.

The copper production of Alaska in 1917 was about 88,200,000 lb. This is less than the production in 1916, which was 119,600,000 lb., but is greater than the production of any other year. The reduction in output was mainly caused by labor troubles at Kennecott's Bonanza mine. During the year 17 copper mines were operated, compared with 18 in 1916—eight in the Ketchikan district, six in the Prince William Sound district, and three in the Chitina. The output of the Kennecott mines in the Chitina district overshadowed that from all others.

About 232 tons of stream tin was produced in Alaska in 1917. Most of this came from the York field, where two tin dredges were operated. Developments were continued on the Lost River lode-tin mine. The rest of the concentrates were recovered incidentally to placer-gold mining, chiefly in the Hot Springs region. The mining of antimony ore began in Alaska in 1915 and continued on about the same scale throughout the first half of 1916, when a fall in the price of antimony put an end to most of these operations. In 1917 mining continued at two properties in the Fairbanks district.

The Fairbanks district and Seward Peninsula were the principal producers of tungsten in Alaska in 1917. In the Fairbanks district two tungsten mines were in course of development. At one of these mines one unit of a 75-ton mill was in operation and late in the summer was turning out several hundred pounds of scheelite concentrates daily. At the other mine a similar mill was in course of construction. Underground work was in progress at both mines. The present indications give promise of a large increase in the production of tungsten in the Fairbanks field. In Seward Peninsula tungsten was produced principally by sluicing the residual scheelite-bearing lode material in Sophie Gulch. Smaller quantities were recovered as the result of placer mining at other places.

The production of petroleum from the only oil claim patented in Alaska, in the Katalla district, increased somewhat in 1917. Drilling continued on a small scale, but no new productive wells were obtained. About 61,000 tons of coal, valued at $300,000, was mined in Alaska in 1917. The largest production was derived from the Eska Creek mines, in the Matanuska field, which were taken over by the Alaskan Engineering Commission. Coal was mined also at the Doherty mine, in the Matanuska field; at the Bluff Point mine, on Cook Inlet; on Cache Creek, and near Candle. The most

important event of the year in connection with coal mining was the completion of the Matanuska branch of the Government railroad. The high-grade coal on Chicaloon River is now being opened by the Alaskan Engineering Commission, and small shipments to Anchorage were reported. Work preparatory to mining was undertaken on Moose Creek by private lessees.

The coal lands in the Nenana coal field were subdivided and will be offered for leasing at an early date. The Government railroad is now being built southward to this field from Nanana, on the Tanana River, and will probably reach the field and make the coal available for river shipment in the summer of 1918. A private railroad from Controller Bay to a patented coal claim in the eastern end of the Bering River field was under construction.

In southern Alaska nine gold-lode mines, eight copper mines, and two placer mines were in operation in 1917. In the Ketchikan district no gold mines operated. Gold-lode mining on a large scale continued at the Alaska-Juneau and Alaska-Gastineau mines. The first units of the new mill were placed in operation and treating in October about 4000 tons daily and the Alaska-Gastineau 7500 tons per day. The Treadwell and Mexican mines were flooded by the sea and abandoned. The Ready-Bullion, though connected underground, was protected by a bulkhead, but precautions reduced the normal capacity to one-third.

In the Copper River basin the Jumbo and Kennecott-Bonanza were the largest producers. On Prince William Sound six copper and seven gold mines operated. In the Susitna region Willow Creek produced from four lode mines. Cache Creek continued to be the principal source of placer gold in the Yentna basin. In the Yukon basin $6,500,000 worth of gold was produced in 1917. The principal camps in order of output were: Iditarod, Fairbanks, Tolovana, Ruby, Hot Springs, Marshall, Koyukuk and Circle. In addition the Fairbanks district produced lode gold, silver, lead, antimony and tungsten. In the Kuskokwim basin production was limited to placers on about the usual scale. On the Seward Peninsula the gold output was $2,700,000 and in addition the district produced some stream tin, tungsten and graphite.

Mining in Ontario in 1917

By THOMAS W. GIBSON*

THE value of the metal output of Ontario in 1917 was about $58,000,000, or nearly $3,000,000 more than that of 1916. There was probably a small decrease, say $250,000 or $300,000, in the value of the non-metallic production. The net result, therefore, was an increase in the total value, as compared with 1916, of over $2,500,000. This was due in the main to the higher prices prevailing for three out of the four chief metals of production—gold, silver, nickel and copper.

Gold Output Diminished

The constantly rising cost of labor and supplies reacted against gold mining. The output was about $8,750,000, as compared with $10,339,259 in 1916. Part of the falling off was due to the closing of the Dome mill in November. The Dome ore is low grade, and while producing a profit in normal times, could not contend with present conditions. Production for nine months was $1,219,000. All the other Porcupine properties, however, continued to operate. Hollinger, the largest mine, while suspending dividends for part of the year, turned out bullion to the value of about $4,450,000. McIntyre-Porcupine had an output of about $1,600,000. Other mines in the producing group were Porcupine Crown, Porcupine-Vipond-North Thompson, and Schumacher. Dome Lake also produced a little bullion. Two or three other properties are developing and will in time add to the output. The total for the Porcupine camp was about $8,300,000.

There are now two mines at Kirkland Lake in the producing class; namely, Tough-Oakes and Teck-Hughes. Lake Shore, Kirkland Lake, Wright-Hargreaves and other prospects are under development, and when the mills now being constructed are completed there will be a treatment capacity of 530 tons of ore per day. Other gold camps, all promising, but in the earlier stages of development, are Munro Township, Bourke's, Boston Creek, West Shining Tree, Tashota, Dryden and Powell-Cairo. Sturgeon Lake has not yet begun to produce since reopening, and Long Lake (Canadian Exploration Co.) has ceased operations.

In Munro, the Croesus mine, the shaft of which showed quartz of phenomenal richness, is being explored at a depth of 400 ft. Buff-Munro is another good-looking prospect. The Anderson farm, at Bourke's, is developing favorably, and Murray-Moggridge, at Wolf Lake, is well regarded. The principal Boston Creek properties are Miller Independence and Boston Hollinger (now Patricia). West Shining Tree shows samples containing much free gold.

There is usually at least one new gold area located in Northern Ontario each year. That for 1917 is near the headwaters of Lightning River, a small stream which flows into Lake Abitibi from the south. A good find was made here last autumn by a prospector named Cochenour, and a number of claims have already been staked out. The camp is about 30 miles from the Temiskaming & Northern Ontario Ry., not far from the Quebec border, and is reached by a trail from Kirkland Lake, the railway station being Swastika. Geological conditions are said to resemble those of the Porcupine district.

Nipissing Loses Long-Held Position of Premier Silver Producer

The Ontario output of silver in 1917 was about 20,000,000 oz. Production came almost entirely from the mines of Cobalt and outlying camps. The Mining Corporation of Canada assumed the rôle of leading producer, so long held by Nipissing. This company operates two mines, Townsite-City and Cobalt Lake. A

*Deputy minister of mines for Ontario, Toronto, Can.

rich system of veins is being worked in the Townsite-City beneath the streets and buildings of Cobalt, including the Timiskaming & Northern Ontario Ry. station, and yields much high-grade ore. Perhaps one-quarter of the entire silver yield from Cobalt in 1917, over 5,000,000 oz., came from these workings.

Nipissing had a good year, producing about 3,750,000 oz., nearly equal to its output of 1916. This mine has established a record for dividend payments, up to the present, of more than $17,000,000. Kerr Lake also nearly equalled its output for 1916, about 2,275,000 oz. Coniagas turned out about 1,300,000 oz. and McKinley-Darragh-Savage, 1,000,000 oz. O'Brien and Temiskaming had good yields. Beaver, Buffalo, Crown Reserve, La Rose, Hudson Bay, Trethewey, etc., also turned out bullion, but for the most part on a reduced scale. The unusually rich lode at Miller Lake-O'Brien has given this mine an important place, and is leading to a revival of interest in the Gowganda camp. A number of the once-famous mines at Cobalt are fast becoming memories; nevertheless, the aggregate production for 1917 was probably equal to that of 1916, and the receipts from sales of silver, owing to the marked rise in price, were nearly $3,300,000 greater. What seems to be a good find of native silver was made by a prospector named Kell, in Corkill Township, Gowganda Mining Division, a considerable distance southeast of the known deposits.

The metallurgical feature of 1917 was the rapid advance of the flotation process of concentration. This will enable many million ounces of silver to be recovered from hitherto valueless tailings and will add materially to the life of the camp. Stout resistance was offered by the Cobalt companies to the royalties asked by Minerals Separation and the matter was referred to the Government of Canada for investigation.

Progress in Nickel and Copper

The mattes produced by the Sudbury smelters in 1917 contained about 41,500 tons of nickel, say 200 tons more than in 1916. At 27½c. per lb. the value of the nickel in matte form was $22,400,000. In 1916 the production, on a basis of 25c., was valued at $20,649,279. Both producers, the Canadian Copper Co. and the Mond Nickel Co., maintained a high level of production, and each is now adding another furnace to its smelting equipment. The Copper company drew upon the Creighton and Crean Hill mines for the bulk of its ore, No. 2 mine having been closed down during the year. Production from the Creighton shaft rose occasionally as high as 5000 tons per day, and is now averaging 100,000 tons per month. The new rockhouse at this mine, of steel-frame, hollow-tile and cement construction, is one of the most complete on the continent. The Mond company raised its ore from the Garson, Victoria, Worthington and Levack mines. The Alexo mine, in Dundonald, had a small production.

The report of the Royal Ontario Nickel Commission, published early in 1917, estimated the "proved ore" of the Sudbury region at 70,000,000 tons. The results of diamond drilling since that time have, it is said, at least doubled these figures. Extensive drilling was done at the following mines: Levack, Frood Extension, Murray, Falconbridge (Longyear Syndicate), and in the Creighton area. At the Victoria No. 1 mine, the Mond company is putting the shaft down from 2600 to 3000 ft. The British America Nickel Corporation had about 400 men at work on the power plant and smelter buildings at the Murray mine, and sunk a shaft about 800 ft. At Port Colborne, the International Nickel Co.'s plant for treating the Canadian Copper Co.'s mattes is nearing completion, and will be refining nickel and copper early in 1918. The works have an initial yearly capacity of about 10,000 tons of nickel, and a corresponding quantity of copper.

Litigation against the nickel companies for damage to crops was brought to a head during the year, Judge Middleton granting damages, but on a much smaller scale than was claimed. The Canadian Copper Co. removed its roasting yards to Mileage 17 on the Algoma Eastern Ry., where the likelihood of damage being done is less than at Copper Cliff, and the Mond Nickel Co. has given up heap roasting in the summer time.

Copper in Ontario is a byproduct of nickel, the ores of Sudbury carrying on an average 1.5% Cu. The mattes in 1917 contained approximately 21,250 tons of copper, or about 1000 tons less than in 1916. The value, at 18½c per lb. in the matte, was, say, $7,650,000. A quantity of non-nickeliferous ore was raised from the Tiptop and Mine Centre mines, also by the Sudbury Copper and Kenyon Copper companies. At the plant of the last named, near Massey station, an oil flotation process was installed.

Iron Ore and Pig Iron

Two Ontario mines produced iron ore in 1917—Helen and Magpie—both owned and operated by the Algoma Steel Corporation. The combined production for nine months ended Sept. 30 was 138,808 tons, of which about two-thirds was exported to Lake Erie ports in the United States, the remainder being sent to the company's own furnaces at Sault Ste. Marie. The ore from these mines is treated in the roasters at the Magpie plant for reduction of the sulphur contents of both ores, and the elimination of the carbonic acid from the Magpie ore, which is a siderite. The product is a good grade of bessemer material, containing a considerable percentage of manganese, and is in demand by United States ironmasters.

Blast furnaces at Sault Ste. Marie, Port Colborne, Deseronto and Hamilton produced 513,232 tons of pig iron up to Sept. 30. At the same rate the output for 1917 would be around 685,000 tons. About 10% of the ore smelted was from Ontario mines, the remainder being imported from the United States.

Approximately 540 tons of lead was produced in Ontario during the first nine months of 1917. Most of this was obtained at the smeltery of the estate of James Robertson, Galetta, and the remainder by the Kingston Smelting Co. The ores were mined at Galetta, Carleton County, and at Somerville Township, Victoria County, respectively.

Cobalt, Nickel and Non-Metallic Products

From the silver ores of Cobalt, cobalt and nickel oxides and other compounds, also metallic cobalt and nickel, are recovered as byproducts at the refineries. These substances were produced to the value of over $900,000 for the nine months ended Sept. 30. Metallic

cobalt is coming into use as a component of stellite for high-speed tools. Chromium and tungsten are the other ingredients of this alloy.

Of non-metallic products there is normally an annual production of $10,000,000 or $12,000,000 in value. Arsenic is another byproduct of the Cobalt silver ores, and upward of 2000 tons was made in 1917. Supplies of arsenic, hitherto imported into America from Belgium, England and elsewhere, have diminished, owing to the war, and the price has gone up to 16c. per lb. There are deposits of mispickel in Hastings County and elsewhere, which might be drawn upon to meet the large requirements in the manufacture of insecticides, glass and pigments.

Building materials, such as brick, lime, stone, and cement, are produced in large quantities. In 1916 the output had an estimated value of slightly under $5,000,000. The building trade in 1917 was in the same depressed condition as in 1916, and production was on a corresponding scale.

Petroleum production is declining year by year. Domestic crude now suffices for only a small part of the requirements for refining purposes. The yield for 1917 was doubtless under 7,000,000 Imp. gal. The natural gas supply is feeling the effect of the heavy drafts upon it of late years, and there is at present the prospect of manufacturing industries being deprived of its use in part of the field of distribution. In 1916 the output of the wells amounted to 17,953,396 thousand cu.ft., and for 1917 the figures will be approximately the same. A well put down in Dover Township, Kent County, some distance into the Trenton formation, gave an initial flow of over 6,000,000 cu.ft. per day. The pressure and output have now been much reduced, and oil is taking the place of gas.

Pyrite Mining in Ontario

There are large deposits of pyrite in Ontario, and this material is in active demand as a source of sulphur for the manufacture of sulphuric acid, required particularly in the making of munitions. In northwestern Ontario the mines at Northpines and Goudreau Lake, owned by the Nichols Chemical Co., were extensively worked in 1917, the output being exported to the United States. This company also operates an acid plant and pyrite mine at Sulphide, in eastern Ontario. Other deposits in that section are being worked as well.

The talc industry is expanding. There are now two mills for grinding and preparing talc for the market. The product finds a large use as filling in the manufacture of paper. Finer grades are worked up in the cosmetic trade. The talc-producing mines are in the neighborhood of Madoc.

Fluorspar was in strong demand in 1917, and the price went up to $20 and $25 per ton. The producing area is near Madoc, and is about seven miles wide. The veins vary from a few inches up to 10 or 12 ft. in length. In places the fluorspar carries calcite and barite. In others it is much purer, running up to 90%. The most important development, so far, is on a property owned by Messrs. Wellington and Munroe, on which a shaft has been sunk to a depth of 80 ft., and 130 ft. of drifting has been done at the 65-ft. level. The body of fluorspar averages about 6 ft. in width. Up to Nov. 15, 50 carloads had been shipped from this property, most of it to the Dominion Steel and Iron Co., in Nova Scotia. Consignments were also made from other deposits.

An excellent quality of feldspar is raised from quarries on the Kingston & Pembroke Ry., for shipment to the potteries of East Liverpool, Ohio, and Newark, N. J. Operations continued throughout 1917. About 12,000 or 14,000 tons is annually exported. The principal mica mine is the Lacey, owned by the General Electric Co. It yields the "amber" variety, which is esteemed for electrical apparatus. Production was curtailed in 1917.

Graphite is found in several parts of eastern Ontario. Two companies operated mines and mills in 1917—Globe, at Fort Elmsley, and Black Donald, at Calabogie. The output was about 4000 tons of refined graphite. Perhaps a third of this was flake, used in the manufacture of crucibles, and also for lubricants. The dust, or foundry plumbago, is made up for stove polish, mold facings, and similar uses.

A find of the mineral euxenite is interesting as a source of radium. A feldspar quarry in South Sherbrooke Township contained a zone in which this substance occurred. Unfortunately, examination failed to reveal a commercial supply. Samples of the euxenite contained up to 10.5% of uranium oxide.

Mining in Manitoba in 1917

By R. C. Wallace*

It was pointed out in 1916 that three mineral areas were being developed in Manitoba. These were: The district north of The Pas, the Rice Lake district and the Star Lake region. At the end of 1917 the last two districts were practically as they were at the end of 1916. In the Gold Lake area (Rice Lake district) the Gold Pan mine, which had been closed since June, 1916, was reopened and some phenomenal ore obtained; further work is being carried on. North of Hole River, in the Hay Lake district, some good prospects were opened, but otherwise the district is marking time. In the Star Lake country the only matter of interest in 1917 was the discovery of molybdenite fairly widely distributed in pegmatitic veins. The deposits are possibly of economic value, but no development of consequence was done.

In the district north of The Pas, work of real importance was accomplished in 1917. The western end of this belt shows mixed sulphides, and the eastern end chiefly gold-quartz veins. On both types of deposits substantial work was carried on throughout 1917. On the Mandy Mining Co.'s copper property over 3000 tons of ore were mined in the winter of 1916 and freighted to The Pas, to be transported by rail to the Trail smeltery, in British Columbia. This winter over 10,000 tons will be taken out in similar fashion. Only a high-grade deposit could be handled in this way. At the low-grade Flin-flon property—now the Great Sulphides—drilling was continued during the summer, and it is understood that the extent of this deposit is now fairly well defined. Buildings were erected to accommodate a staff of 85, and it is expected that mining will begin

*Professor, department of geology and mineralogy, University of Manitoba, Winnipeg, Man., Can.

in 1918. It will be necessary to spend a large amount of capital on this property, as operations must be conducted on a considerable scale.

At Herb Lake, at the east end of the belt, shafts were sunk on several gold properties, and the showings encountered justify the expectation of some substantial mines in this section. Nothing can yet be said about conditions below the 100-ft. level, but lateral continuity of the ore in the surface zones was shown. A road was cut from the Hudson Bay railway to the lake by the provincial government. A stamp mill is being erected on the Rex mine, and two or three prospects are preparing shipments at the end of the year.

Though the province had made a nonmetallic production for many years, the first output of metalliferous minerals was in 1917. Moreover, the production would have been much larger were it not for transportation difficulties of a formidable nature. Indications point to a steady and rapid increase in production, both in copper and in gold.

Mining in Mexico

THE status of the mining industry in Mexico in 1917 was, in effect, similar to that of the two or three years preceding. While there was no official let-up in the state of civil war that has existed so long in actual fact the exhaustion of the resources of the country made a condition of real war almost impossible. The only approach to war conditions were the guerilla activities of a few bandits. In the absence of robust authority, even the weakest of these bands is able to overcome the hypothetical resistance offered to it. Under such circumstances, transportation cannot be relied upon, nor can foreign corporations or individuals attempt to develop or operate mines with any degree of security. The supplies necessary are almost impossible to get, and the product, to be exported or shipped to the Federal capital, is more than likely to be confiscated en route by the patriots who happen to be opposed to the government of the moment, whatever it is.

Excessive Taxes Being Levied

The Carranza government has trailed along in a vacillating way, making laws of all kinds, and, consequently, making a lot of exceptions to them. The new mining tax as it is proposed would be a deathblow to mining in the republic, and no one expects it to be enforced rigidly. In the report of the El Oro Mining & Ry. Co., which was offered in October, 1917, the matter was brought out with a good deal of emphasis. The chairman called attention to the fact that taxation has been increased severely and said, further: "With the general increase in taxes throughout the world at the present time, one might not feel disposed to complain of this if it was within reason, but in Mexico it is not. To the mining companies, particularly those owning low-grade mines, it is simply prohibitory. Taking the last completed year of the El Oro company, the present scale of taxation has risen from a sum equal to 11½% of the net profits of the company to 32%. Moreover, the arbitrary increase in wages enforced by the state and federal authorities, and various other penalties imposed upon employers of labor under the new constitution, have raised the working costs in El Oro's case by $3.11—that is, roundly, by 100%—thus rendering unprofitable the treatment under conditions that prevail today of more than half of the ore hitherto included in the ore reserves. Moreover, the framers of the Constitution, with the unconcealed intent of penalizing the employer for the benefit of the workman, went a step further. In addition to innumerable other provisions of this famous document, all having the same object in view, the government is authorized to ascertain the profits of mining companies, and, having done so, to allocate such profits as to it may seem just and fair between the employer and the employed. The operation of mining properties in Mexico has reached a crisis at which the industry must either terminate or be conducted under less onerous conditions."

American companies and American officials have pointed out the discrepancies in the law as framed, and have also made representation as to the practical confiscation of the mining industry that is affected by the laws. It is hoped, and confidently expected, that the laws will be changed radically, either in formula or in their application. The ordinary mining operation cannot stand the kind of taxes that are being levied, and, if it is continued, the mines will be abandoned.

In the States of Sinaloa and Tamaulipas there was practically no mining in 1917. In Durango, the mining industry struggled along weakly under the burden of increased taxation and interrupted transport. The Cia. Minera de Peñoles was more successful than most other properties, having operated at about half capacity in the first half and at about 75% of capacity in the last half of 1917. In the State of Zacatecas, mining was at a complete standstill during the first six months as a result of suspension of railroad traffic and unsafe conditions. Fresnillo Co. resumed operation of its hyposulphite-leaching plant at Fresnillo, and at the end of 1917 was treating about 15,000 tons monthly. At Sombrerete, the Sombrerte Mining Co. resumed operations on a small scale, and at Concepcion del Oro some mines reopened and made small shipments to the Saltillo and Monterrey smelteries. The old mines comprising the camp immediately surrounding the City of Zacatecas were practically dormant, though some surface work was occasionally done.

Operation Possible in Some Parts of Sonora

The mining industry in the State of Sonora was in some ways fortunate and in others unfortunate during 1917. A good part of the state was under the influence of the Villa raiding bandits, and consequently was not able to call its gold its own. In other sections, especially those that are close to the United States border, it was possible to continue mining at a respectable rate, since transportation was comparatively easy and it was a simple matter to provide a guard sufficient to discourage the bandit raids.

In the Nacozari district considerable progress was evident. At the Pilares mine of the Moctezuma Copper

Co., at Nacozari, the main feature was the construction of a new 50-ft. steel headframe and the installation at the Esperanza shaft of a 400-hp. Nordberg electric direct-geared double-drum hoist. The Pilares shaft ran into ore on the lower level, and is therefore to be replaced by a new shaft about 450 ft. from the old one. Drifts are being run on all levels adjacent to the shaft, and raises were finished to the surface on practically all levels above that at 700 feet. This shaft will be of two compartments, 11 x 18 ft., the reason for its great width being the intention to get a sufficiently large compartment for the 5-ton side-dump cars that are now in use at the Porvenir incline. The average monthly production of the mine was about 65,000 to 70,000 tons

The Mines Co. of America, at Minas Prietas, Dolores, and its other properties did not carry on any operations in 1917. The difficulties in the way of continuous operation, the danger of maintaining Americans at the properties, and the practical impossibility of getting supplies in or products out, made work impossible.

The Greene-Cananea Copper Co. operated on a normal scale up to June. The property was then shut down, due to difficulties with official labor committees and the transportation of material. The works remained closed until early in December. At the end of 1917 operations had reached about 80% of normal, with 100% capacity in sight about 30 days thereafter.

The Minas Pedrazzini Gold and Silver Mining Co. near Arizpe, Sonora, was under limited operation in 1917, mining in a small way, principally in Las Chispas mine, for high-grade ore carrying 300 oz. silver and 2 oz. gold per ton, which was shipped to Douglas, Ariz.; the concentrating and cyanide mill was not in operation.

El Oro and Pachuca Districts

In the State of Mexico, the El Oro district is the only one that kept up any semblance at production. The El Oro Mining & Railway Co. did some work, the Mexico Mines of El Oro accomplished probably a little less, and the Esperanza, in about the same condition as the Dos Estrellas, worked at a fraction of its normal capacity.

In the State of Hidalgo, the Santa Gertrudis, La Blanca, San Rafael, Francisco, and the two operations of the United States Smelting, Refining and Mining Co., at Pachuca and at Real del Monte, were the principal producers. The report of the Santa Gertrudis Co. for the year ended June 30, 1917, shows profits amounting to £1798. Mill operations were reduced to about 53.2% of capacity. Transportation difficulty no longer exists, and arrangements having been completed for a supply of cyanide, production is again brought up to full capacity.

Jalisco

In the State of Jalisco conditions were probably more favorable than in almost any other of the Mexican states. The City of Guadalajara, while the center of considerable unrest among some of the classes, has not been subjected to disturbance, and has formed a center about which business negotiations might revolve with considerable security. The Cinco Minas Co. and the Amparo Mining Co., the two large operators in the state, worked continuously. Having the resources, both in finance and skill, they were able to make their own importations of dynamite, caps, fuse, carbide and like materials, but encountered many troubles and difficulties. The fact that they are operating shows the amount of energy that was put behind their efforts. Flotation was experimented with considerably in the state, and a fairly general conclusion is that, with cyanide available at a reasonable price, flotation has no benefits for districts situated as the Jalisco camps are.

At Monterrey, Neuvo Leon, the Mexican Lead Co. was operating its mining plant at about 50% capacity. The San Luis Potosi smeltery (Cia. Metalurgica Mexicana) and the Teziutlan smeltery (Teziutlan Copper Co., State of Puebla) were finishing preparations for starting operations. In this connection a proper coke supply was arranged and the necessary railway equipment, both of cars and locomotives, for bringing in coke and for shipping the product, was provided. At Teziutlan the hydroelectric plant, transmission line, smeltery, mines and railway were restored to working condition late in 1917 and all departments were in operation except the blast furnaces and converters.

Mining in Cuba in 1917

The mineral industry of Cuba in 1917 was, generally speaking, in a prosperous condition. The mines were worked continuously, and large quantities of ore were produced. The deterring factor, as was the case with all countries where water transportation had to be taken into consideration, was the shipping—the scarcity of ships and their vital necessity for other purposes resulting in a somewhat reduced rate of export.

MINERAL PRODUCTS EXPORTED FROM CUBA IN METRIC TONS

	1914–1915		1915–1916		1916–1917	
Asphalt:	Quantity	Value	Quantity	Value	Quantity	Value
United States	449	$11,070	604	$15,294	469	$12,229
Copper Ore:						
United States	82,453	1,530,700	82,290	4,229,652	115,036	9,829,938
Iron Ore:						
United States	759,971	2,083,688	842,598	2,389,124	580,280	1,746,870
Manganese:						
United States	53,173	161,247	20,329	359,834	34,741	462,806
Italy	1,985	22,835	.....	.....	.....	.....
	55,158	184,082	20,329	$359,834	34,741	$462,806

MINERAL PRODUCTS EXPORTED FROM VARIOUS CUBAN PORTS IN METRIC TONS

	1914–1915		1915–1916		1916–1917	
Asphalt:	Quantity	Value	Quantity	Value	Quantity	Value
Caibarien	398	$10,283	555	$14,714	415	$11,499
Cardenas	51	787	46	506	42	475
Habana	.....	.....	3	74	.....	.....
Matanzas	.....	.....	.....	.....	12	255
Totals	449	$11,070	604	$15,294	469	$12,229
Copper Ore:						
Cienfuegos	32	100	.....	.....	.....	.....
Gibara	.....	.....	.....	.....	166	13,867
Habana	48,025	540,100	23,359	333,039	2,068	111,482
Manzanillo	5	1,187	.....	.....	.....	.....
Mariel	.....	.....	24,940	2,494,000	78,250	7,815,000
Nipe	.....	.....	8	750	11	1,260
Santiago de Cuba	34,391	989,313	33,983	1,401,863	34,541	1,888,329
Totals	82,453	$1,530,700	82,290	$4,229,652	115,036	$9,829,938
Iron Ore:						
Habana	.....	.....	.....	11	45	1,025
Nipe	248,661	611,512	299,755	891,752	260,974	774,925
Santiago de Cuba	511,310	1,472,176	542,843	1,497,361	319,261	970,920
Totals	759,971	$2,083,688	842,598	$2,389,124	580,280	$1,746,870
Manganese:						
Habana	.....	.....	13	260	165	5,332
Manzanillo	.....	.....	.....	.....	.....	.....
Nipe	2,174	26,927	10,673	224,360	4,539	102,602
Santiago de Cuba	52,984	157,155	9,643	135,214	30,037	354,872
Totals	55,158	$184,082	20,329	$359,834	34,741	$462,806

The principal mineral products of Cuba are asphalt, copper ore, iron ore and manganese. Of these only copper and manganese showed an increase in volume of exports. A few new mines were opened and some prospecting was done, but neither of these reached a scale that might be called large. During the first half of

the year, commercial oil production began at the Union Oil Co.'s No. 5 well, near Guanatacoa, which produced a high-grade distilling oil.

The accompanying tabulation showing the exports of minerals and ores from Cuba from 1914 to 1917 gives a good idea of the development of the industry in that period. The figures were contributed by D. Pablo Ortega, in charge of the Direccion de Montes y Minas of the Cuban Republic. They show, in the first table, the total shipments to each of the countries to which the material was exported, and, in the second table, the exports from the various ports of Cuba.

Central America in 1917

In general the course of events in Central America in 1917 followed the usual rule that applies to most of the South American countries. Development continued to a certain extent, but it cannot be said to have been lively. Investment in mines was limited by war conditions, which hampered the use of capital for any but war purposes and the necessaries of life and commerce.

The Sinclair Central American Oil Co., through L. G. Valentine, one of its directors and vice president of the Costa Rica Oil Corporation, a company recently organized by the Sinclair company, signed a contract with the Panama government, authorizing the company to inspect and exploit for oil deposits a strip of land 15 miles wide along the parallel to the Pacific and Atlantic coasts. The concessionaire will pay to the national treasury a sum equivalent to the exploitation expenses of an area of 50,000 hectares, and within three years after signing the contract must declare definitely the zone which is to be explored, the total area of exploration, not exceeding 2000 square miles, which, the government agrees, may be explored during a period of 20 years. At the option of the concessionaire the concession term can be renewed at its expiration. This announcement was made in June. An exploring party is in the field, and apparently some serious work will be done.

Tonopah Mining Acquired Rosita Mine

Early in 1917, and without ostentation, the new Tonopah-Nicaragua Co. began operations at the old Santa Rita mine, originally owned by W. B. Parker. The old Santa Rita is now known as the Rosita mine, and the Tonopah-Nicaragua Co., a new subsidiary of the Tonopah Mining Co., of Navada, has acquired full title not only to this but to other large deposits in the immediate vicinity. Development work is already under way, and a large reduction plant is in view. What the advent of the Eden Mining Co. has meant for the Pispis district of Nicaragua no doubt will be duplicated for the Tunkey section, resulting in a larger production and increased development for the district. The Eden, the Santa Rita and the Bonanza mine are thus under one management. The Eden Mining Co. started its new mill on Mar. 17, 1917, at a capacity of 150 tons per day. The Constantia Consolidated, the Lone Star and the Concordia are all running to their capacity. These developments are notable in gold mining and metallurgy for Central America and are operations of the first importance. There was considerable discussion about oil in Nicaragua, and while it is believed to occur there, the geological formation being similar to that in Costa Rica, no one knows specifically where the oil is. It is probable that oil development will take place in the not distant future.

The secretary for the London agents of the liquidators of the Butters Salvador Mines, Ltd., states that, with the authority of the courts, the first distribution of 65c. a share is to be made to all shareholders. Having received reports from the manager of the property in Salvador indicating the early exhaustion of the mines, it was decided to place the company in voluntary liquidation. Included in the assets is an interest in a mine situated in the Republic of Nicaragua, which is a small but promising property. Milling operations with a small plant have already begun and profits are being made.

Honduras and Guatemala

In Honduras, the Honduras Mining Co. took over property in the Department of Olancho, near the village of Limones. The prospectus of the company sets forth that the property consists of a mining zone under grant from the Honduras government amounting to about 144½ acres. Several veins within the area were prospected, the principal one having a shoot of ore about 100 ft. in length showing a body of quartz from 6 to 40 in. in width and averaging about 30 in. Assays taken along the surface indicate an average value of about 1 oz. of gold per ton. The work on this property has not gone far enough to demonstrate its value definitely, but it is understood that development is being continued. R. H. Burrows is the manager for the company, with headquarters at Galeras, District of Olancho, Honduras.

The New York and Honduras Rosario Mining Co. had one of the most prosperous years of its existence. Work was prosecuted vigorously and the plant capacity increased to 11,500 tons per month, the ore maintaining its normal grade. Prospecting was carried on energetically. Properties, aside from the company's main holdings, were under examination with a view to purchasing them, and at one of these development is under way and a flotation plant in process of erection.

Early in 1917 it seemed that there was a quickened interest in mining in Guatemala but it gradually slackened in the later months, due, no doubt, to the increased difficulty of importing and the cost of materials, the gradual tightening of the money markets, and the increased difficulties in exporting the products. The most active district for metal mining was that of Conception, where the Minas de Alotepeque are situated, as that company had employed steadily about 200 men. Several hundred feet of development was done, and the construction of the new 25-ton mill was finished. The mill, however, closed after a few months operation and later work was suspended temporarily on the entire property. The Huehuetenango district continued, as usual, to pro-

duce considerable lead for home consumption, and in 1917 a number of tons were produced for export. Activity began early in 1917 in the Mataquescuintla district and still continues. It is reported that the principal property is under option to an American company. It is essentially a low-grade copper property containing, also, small veins of high-grade ores.

The new Loreta chrome mine, in the Department of Progreso, which started shipping about June and had shipped, up to Dec. 1, 200 tons of high-grade chrome ore. This is a new product for the country, and the prospects for a small but steady production are encouraging. At the Marble mine a bridge was built across the River Matagua and the inclined cable railroad up to the mine nearly completed. At Guatemala City a cement plant started producing but not capacity.

There are two gold-placer districts in Guatemala where considerable work was accomplished in 1917, the larger of these being that at Quebradas. Here a number of drill holes were put down and a good deal of general prospecting was done, but it is reported that the property is now closed. On the Upper Matagua, the placers are said to be working in a small way.

Costa Rica

In Costa Rica the Ahangarez gold fields was operating under lease by John N. Popham. Results have been, in the main, favorable. The Aguacate mines operated on a normal scale, results having been better than during the preceding year. Considerable prospecting was done. The tenth level of the mine was under development with results that are favorable so far as can be seen. The Costa Rica Manganese and Mining Co., Playareal, Costa Rica, is completing harbor improvements for facilitating shipments and the output is to be increased from 2000 to 5000 tons per month.

South America in 1917

THE important mining properties in South America were operated in much the same way in 1917 as in 1916. There were few if any new developments of magnitude. Most of the energy expended was upon the intensive operation of mines and metallurgical works already in existence. The copper properties, particularly, were subjected to stimulative measures, and the output increased.

An important factor in the production of some South American products, such as manganese ore, was the shortage of bottoms for exporting, which was depressing in its results. The entrance of the United States into the war had the effect of removing many ships from service in the South American trade. This injured the Brazilian manganese industry, and also created a shortage in the United States, the scarcity of manganese affecting the production of ferromanganese for use in steel metallurgy.

Much the same difficulty was encountered in the nitrate fields. Scarcity of ships prevented normal exports, and caused unrest in the industry, which resulted in governmental action, particularly in Chile, designed to assist the nitrate producers.

The entrance of the United States into the war still further restricted capital that might have been available for investment in South American mines, a condition that had already been evident at a continuously increasing rate since the breaking out of the war.

Chile

In recent years Chile has become a center for mining enterprises upon a huge scale, as evidenced by the work at Chuquicamata and at the Braden copper mine. The exploration of the great copper deposits of the Andes Copper Mining Co., the South American auxiliary of the Anaconda Copper Mining Co., fits in on an appropriate scale with these great enterprises, though intensive construction work at Potrerillos will await more favorable prices and shipping conditions. At the end of 1916 came the advent of the American Smelting and Refining Co. into Chile, and the opening of 1917 was hopeful, but with the continuous tightening produced by war conditions and the rise of Chilean exchange, the mineral industry was much upset. Ore buyers, not being able to export the high-grade ores, ceased buying to a certain extent. Smelting plants found a scarcity of coke and imports, and this, together with the rapidly rising cost of local labor and the rise in exchange, which brought down the value of currency in Chile, provided conditions that were highly prejudicial to the industry.

Chanarcillo, in Copiapo, is only very slowly yielding its silver. The Bolaco Viejo mine opened a small pocket of ore in territory that is expected to lead to further development. A company was formed in Valparaiso to work silver groups in Chanarcillo and Lomos Bayos. Some development was done and machinery is being installed. The high price of silver stimulated the silver-mining industry, and considerable attention was devoted to its production in the above-named districts.

Reports of the development of the Andes Copper Mining Co. in September stated that preliminary construction work was progressing rapidly, despite the scarcity of materials and supplies. Under General Manager L. R. Wallace, the work of the company's railroad leading to Potrerillos, a line about 90 km. long, has been partly finished, about 60 km. of grade having been completed and the material for the tracks, rails and ties having begun to arrive. Part of the port and docks work near Chañaral was completed in 1917. Warehouses, machine shops and engine sheds were under construction, and three new locomotives set up for operation. The smelting plant, which will be at or near Chañaral, has not been given much attention so far, and not much progress was made upon the oil-burning steam power plant which is expected to be constructed at the coast. Work at the mine and projected millsite was progressing slowly. The millsite will be about 12 km. below and to the west of Potrerillos. Here the crusher and concentrator, power sub-station, and principal shops and offices of the company will be established. Work on the mine railway to deliver ore from the mine to the millsite was begun and the 3½-kilometer tunnel, which will be one of the features of the line, was started.

The production of copper from Chuquicamata is estimated at about 92,000,000 lb. for 1917, compared with 31,306,476 lb. for 1916. Braden's output is estimated at 65,000,000 lb., compared with 22,152,270 lb. in 1916. Extension of the reduction plants of these two companies was under way in 1917. Exports of copper from Chile as a whole for the first nine months of 1917 amounted to 58,573 tons, which is an increase of 14,180 tons compared with the corresponding period of the previous year.

It was announced early in 1917 that E. I. du Pont de Nemours & Co. had acquired from the government of Chile two additional nitrate areas in the northern part of the country and would begin at once to develop them. Shipments were expected to begin within a year from that time. The purchase was expected to increase the annual supply of nitrate of soda for use in the United States more than 100,000,000 lb. The nitrate industry was hampered during the year by lack of fuel. It was said that during part of 1917 the *oficinas* were receiving only about 50% of the petroleum they required for fuel purposes, as a result of which some had to shut down and others curtailed their activities.

A tin smeltery was under construction at Arica to take care of the Bolivian tin ores, mainly those of the Llallagua mine. This company controls the Cia. Chilena de Fundición de Estaño which built the new plant. It is to have a capacity of 375 to 700 tons of raw material per month, equivalent to about 225 to 420 tons of fine tin.

The Central Chile Copper Co., Ltd., at the meeting held in London in December, 1917, reported a copper output for the 10 months ended Oct. 31 of 2420 tons. The matter of obtaining fuel and shipping facilities and their enormous cost—often more than five times what it was before the war—were serious factors. In June, 1917, the New York contract for refining the production expired, and the effect of this was that the sale of the output can now be made only under permits granted by the Ministry of Munitions for short periods, so that a contract cannot be made for any length of time ahead, and as a consequence the company is deprived of terms which it might otherwise be possible to obtain. The present refining charge on matte is 3c. per lb., equal to about £14 per ton of copper, as against 1.40c.—say, £6 10s. per ton—before the war.

Tin and Tungsten Developments in Bolivia

In Bolivia considerable work was done in the tin mines in 1917, the Patiño and Llallagua mines leading as usual. The Aramayo Francke Mines, one of the principal operating companies in Bolivia, reported early in 1917 that its operations for the fiscal year produced a net profit of £167,557. This was through sales of tin produced from its mines, and from tungsten, copper, bismuth and copper matte. It was noted that a good deal of new ground was opened and that the mines continued to be worked on a satisfactory basis, although there was great difficulty in shipping the products to England. Sales of silver ore produced £8296, while the production of black tin amounted to 2095 tons, an advance of 34 tons over the output of the previous year. The production of tungsten was 148 tons, this being, of course, not pure, containing considerable tin. The production of bismuth was 148 tons. That of copper matte was equivalent to 35 tons of metallic copper. The production of silver in sulphides and cement reached 110,000 oz. Better conditions for labor and transport are awaited for restarting work on tin in the Tasna section. Chocaya continued to develop favorably, as shown by the year's production.

Record Copper Output of Peru

In Peru the Cerro de Pasco and Backus & Johnston continued to be the principal producers. These large copper-producing companies are now closely allied. In October, the Cerro de Pasco Mines Co. reached a high record, with a production of 7,325,033 lb. of copper, compared with the previous high record of 7,041,261 lb. for September. The average monthly production of copper at La Fundición in 1917 was 5,989,802 lb. over the 10 months, compared with an average monthly production of 5,918,565 lb. for the similar period of 1916. The production of the Backus & Johnston smeltery, at Casapalca, in October amounted to 2,116,819 lb., bringing the average monthly production for 10 months up to 2,023,842 lb. Development at the Sayapullo copper-silver mines was continued under the renewed option to A. J. Bennett and associates.

The Peruvian Congress enacted a law, taking effect Aug. 4, 1917, imposing a progressive tax on crude petroleum and its products whenever the quotation in New York for Pennsylvania crude oil reaches $1.20 per bbl. of 42 gal., which is equivalent to a quotation of $8.40 per metric ton. The law provides that the tax shall be 10c. per metric ton of crude petroleum and residues and 15c. per metric ton on distilled products. For every 10c. rise in the New York quotation per barrel of Pennsylvania crude, there shall be a corresponding increase of 6c. per metric ton in the price on crude petroleum and residues and 9c. per metric ton in the tax on refined petroleum. For the purposes of the law, all products reaching 30° or above in the Baumé scale are to be considered refined.

According to a report, the Andaray gold mines, in the Province of Condesuyos, Department of Arequipa, were under the consideration of American capitalists. The port of Quilpa is the one generally used for access to the mines, which lie 135 miles inland. Caylloma, capital of the province of that name, situated approximately 150 km. northwest of Arequipa, was practically destroyed on the morning of May 21 by an earthquake. Graham, Rowe & Co., agents for the Caylloma silver mines were informed that neither the mines nor the plant suffered any serious damage, but the earthquake seriously damaged the service buildings of the company.

Ecuador

In Ecuador during 1917 there was no material change in the status of the mining industry. No new mining developments were reported. The South American Development Co., at its gold mines in the District of Zaruma, Province of El Oro, continued active construction and operations. The new milling plant was nearly completed. It is of 250 tons capacity, consisting of stamps, Allis-Chalmers 6 x 14-ft. pebble mills close-coupled with Dorr classifiers, followed by the Dorr counter-current decantation method of cyanidation and Merrill zinc-dust precipitation system. The agitation tanks and decantation tanks are built of reinforced concrete, 12 ft. deep by 29 ft. diameter and 12 ft. deep by

39 ft. diameter, respectively. The superstructure and roof support are of steel supplied by the Kansas City Structural Steel Co. A steel headframe, 90 ft. high, was put into service, the material having been supplied by the Lackawanna Bridge Co. The delivery and shipment of machinery and supplies was seriously delayed, causing enormous handicaps to the enterprise in both construction and operation. The South American Development Co. continued its activities in sanitation and welfare, the campaign against the hookworm resulting most satisfactorily in a practical eradication from the immediate camp. A new hospital, built of concrete, brick and tile, was completed and put into service. For 1917, the production of the Zaruma district is estimated at slightly over $600,000, principally gold, with a little silver, and for all Ecuador about $700,000.

The last session of the Ecuadorian Congress was rendered interesting by the presence in Quito of two groups of American capitalists, both seeking petroleum concessions in the northern republic. G. E. Bubar represented the International Petroleum Co., Ltd., which controls the principal operating fields in Peru. The other American syndicate seeking a similar concession in Eucador was the Ohio Cities Gas Co., a small concern in comparison with the International. The financial responsibility of the Ohio Cities Gas Co. was guaranteed by the Central Trust Co., of New York. Largely as a result of the competition between these two concerns, the Ecuadorian Congress failed to arrive at a decision in favor of either and adjourned without having taken any action in this regard.

Colombia

The South American Gold and Platinum Co. operated its dredge in the Condoto River bed, producing both gold and platinum. Part of the equipment for the new 5½-cu.ft. dredge was delivered at the property, but not yet erected. The Pato operations were carried on as usual, part of the year in rich gravel.

According to the report of the Nechi Mines, made in July, 1917, it was shown that the Nechi dredge treated 1,617,975 cu.yd., the gross value of gold recovered being $651,068, or an average of 49.27c. per cu.yd. The field costs for the period averaged 15.2c. per cu.yd. The year's operations disclosed that, owing to the looseness and fineness of the gravel, the dredge could handle, operating at full capacity, nearly twice the yardage upon which the original calculations were based. Dredging was not carried out to bedrock in 1917, and therefore the richest and best material was not touched. This is to be left until later, the company figuring closely on what its excess war tax is going to amount to, not caring now to deplete too greatly the value of its reserve.

The Paris-Transvaal Gold Mines, Ltd., a British registered company, acquired from the Consolidated Colombia Platinum and Gold Mines, Ltd., a 50% interest in the Opogodó placer and the Bolivar and Colonia Mines, also a placer property consisting of about 4 square miles on the River Guapi in Colombia. The acquisition of these properties is of considerable importance because the Opogodó has been prospected by Messrs. Higgins and MacKay with a reported gross value of £1,892,662 in platinum and gold.

The Cia. Salinera de los Andes, of Bogotá, a Colombian corporation, ordered machinery and motors from the United States for the operation of its salt mines at Zipaquirá, in the Department of Cundinamarca. It is reported that a representative of a group of American promoters is in Bogota endeavoring to obtain the transfer of an important concession for the development of petroleum land.

Oil Development in Venezuela

In Venezuela there is little to report for 1917. The most important activity in the metal mines was the resumption of operations by the South American Copper Syndicate at its smelting works for the Aroa mines. Oil development was continued by a number of companies, principally in the region surrounding Lake Maracaibo, and it is reported that a small oil refinery was erected. The Venezuelan Oil Concessions, Ltd., continued its development campaign and the drillings indicated a considerable extent to this field, although as yet undefined.

More Manganese Discovered in Brazil

In Brazil the work at the St. John del Rey and the Ouro Preto, the principal gold mines, continued. The report of the Ouro Preto, in June, 1917, showed that 87,624 tons of ore had been milled and 30,244 oz. of gold produced. The total production for 9 months was valued at £90,095. The grade of the ore treated was 11.03 grams of gold per ton. The ore reserve stood at 72,360 tons. The report of the St. John del Rey Mining Co., in August, 1917, shows profits of £81,938 for the half-year. Ore reserves are maintained at about a million tons, as has been the case for the last year. A feature of importance was the discovery of a large belt of manganese on the company's property, which will be developed to some extent to take advantage of existing demand for this ore. Total gold production for 11 months was valued at £439,024.

On account of the high prices ruling for manganese ore there was a feverish hunt for it in Brazil and some new deposits were found. Developments were instituted at some of these discoveries. The known producing mines continue as before, only the problem of shipping being unfavorable. Of the older producers the Moro de Mina and the Cucurato are the most important. New discoveries are near Barhacina, Nazareth and Araxa. Near the latter point there is a considerable deposit of good ore, but it is too far from the railroad to be considered under present conditions.

Argentina and the Guianas

Development of mining in Argentina in 1917 was at a low point. There were some shipments of sorted ores and concentrates, particularly of tungsten, but this material was not of the highest grade. Gold and most metal mines of Argentina have not been especially successful in the past and 1917 was no exception to this rule. Petroleum, it is reported, was being extracted in October from Argentine wells in the Comodoro Rivadavia field at the rate of 4000 cu.m. per week.

In the Guianas, gold and diamond mining continued in desultory fashion and the most active interest was in bauxite exploration. A number of large North American corporations had representatives in the Guianas developing the known deposits and prospecting new areas.

Russia in 1917

By J. P. HUTCHINS*

OWING to restrictions due to the war, I have been unable for three years to send my annual report reviewing the conditions in Russia. Since the revolution began it has again become possible to contribute. Statistics, as far as available in this time of stress and difficulty, will be given for 1914, 1915, 1916 and 1917, in the endeavor to supply in the present article the data that would have been printed for each year. A brief description of the general condition of mining previous to the war will be attempted as well as a short summary of the course of those events which have occurred since the outbreak of the war and which have had a marked or peculiar effect upon mining in Russia.

Possibility of American Interest in Future

Inasmuch as there is a considerable American interest in the future of mining in Russia, attention is here directed to the possibilities for activities by American capital and by American engineers. Russia has been a country rather of romantic interest than of commercial investigation and exploitation from the American viewpoint, and the resulting picture has been a canvas depicting what one has got from reading the often brutal but picturesque descriptions by Turgenieff, Dostoyevsky, Tolstoy and other novelists as well as the highly colored and usually more florid than accurate accounts of peregrinating travelers, of temporal war correspondents and of writers of "sob-stuff" for current magazines and American and English newspapers. Russia probably has been misrepresented in most of these instances unintentionally, due to strong prejudices that existed in the minds of writers from democratic countries usually unable properly to focus their microscopes upon the more or less obvious features of an autocracy.

Then there have been statements by recent visitors to Russia and by eminent Americans such as that published in the American press in August, that "There is no more disorder in Russia than in America," although disorders, incendiarism, rioting and the other anarchistic happenings of a revolution in full swing were going on and are continuing. There have also been what seem to be willful distortions by American writers who may charitably be called perfervid protagonists of religious principles, innocently slandering Russia, or who are cold-blooded puppets of German propaganda. From all of these Russia has suffered, for it has been quite as harmful to make Russia seem a country with the sun obscured by the clouds of dust raised by thousands of criminals and exiles clanking to the salt mines of Siberia as to picture it a Utopian democracy of perfect order brimming with opportunities for American capital. Some attempt will be made to give a summary of the conditions as these will effect the profitable investment of American capital and the employment of American engineers in Russian mining.

As has generally been appreciated, Russia is backward, largely because of the policy of a pernicious government, which, being in the hands of a few who exploited the many, considered it advantageous to keep the masses in ignorance, actually preventing education as something actively dangerous to its existence. Its fiscal policy as to the governmental monopoly of the sale of vodka debauched all labor. Thus the Russian laborer was expensive when the cost per unit of production was counted, although his wage was low, 25c. to $1 per day. As an example, drift mining for gold in Siberia, with physical and climatic conditions similar to those of Klondike, cost four times as much per cu.yd., although the respective wages were two rubles or $1, and $6 per day. The production of agriculture per acre cultivated was low, less than 20% of that of other countries with similar soil and climate.

In addition to inferior labor, the circumstances that the physical conditions of iron and coal deposits are not favorable to low mining costs, and that there is not usually an advantageous juxtaposition of iron to coal, have mitigated against low manufacturing cost. Thus Russia has generally been unable to compete in the world markets or even to satisfy its own demands, and has been an importer of nearly all mining products except petroleum, manganese—export of which was made possible by favorable conditions of accessibility to foreign transport—and platinum, with its unique advantage of almost exclusive existence in the Urals. It is easy to understand why contiguous Germany, with cheap coal, iron and with efficient and inexpensive labor, and consequently low manufacturing cost, sent nearly 60% of all of its exports to Russia. The per-capita consumption of metals and minerals was low; as compared with that of the United States, copper is only about 15% and aluminum only about 3 per cent.

The Effect of the War

The prohibition of the sale of vodka, which was a military measure aimed principally to prevent drunkenness during the period of mobilization, has had a profound effect, and whereas, before the war, the extent of drunkenness was shocking, now there is only an inconsiderable amount where there is a clandestine traffic in spirit, much increased, unfortunately, since the beginning of the revolution. The effect of prohibition was to increase the efficiency of labor from 30 to 50 per cent.

The mobilization of millions of men for military service caused a shortage of labor, with accompanying increase of wages, which increase was not to an inordinate degree, however. Shutting off foreign goods from Russian markets had the effect of stimulating attempts at home production greatly. Scarcity of nearly all products of mining was thus made more obvious than ever, and attempts followed to increase output, but with general lack of success due to the various shortages of labor, materials and transport caused by the mobilization for war supplies. Thus the output of all the more important metals and minerals decreased in the four years under review. Attempts were made by the government to stimulate production by granting loans to mining companies, and by making contracts for output at high prices. These efforts were generally abortive, and the supervision by incompetent bureaucrats of subsidized undertakings has been exceedingly harassing to the management.

*Mining engineer, Petrograd, Russia.

Prior to the war America supplied less than 10% of Russia's imports and took less than 1% of her exports. Of Russia's exports in 1913, aggregating $760,000,000, more than one-third went to Germany, and of her imports of $687,000,000 about one-half came from Germany. This was approximately five-ninths of Germany's total exports. These figures show how Russia was bound to Germany by economic ties, but they also indicate that there are openings for American manufacturers who will really cater to the Russian market. There are and will continue to be opportunities for the profitable investment of American capital in Russian mining and in other businesses as well.

There will be openings for American engineers, especially, of course, when American capital becomes interested. Russian companies have not shown a disposition to employ foreign engineers in the past. It is expected that they will be more progressive in the future. Russia will have places for American engineers. Any one intending to come to Russia, however, should try to learn the Russian language, which is difficult.

Effects of the Revolution

Revolutions are always destructive and then constructive. The revolution is still going on in Russia and will not end for some time. The first phase, during which the autocracy was overthrown, was accomplished with great rapidity and with a comparatively small amount of violence and bloodshed, for there was an almost unanimous appreciation of the incompetence of the corrupt and autocratic government, which had been completely exposed by the merciless and excessive requirements of modern warfare. Since then there has been an upsetting growth and spread of socialistic doctrines, and the result on the productiveness of Russian labor has been disastrous. Wages have risen enormously in the last nine months, and the endless demands for wage increase continue. At the same time the efficiency of labor, which was always low in Russia, has fallen more than 50%, and this condition is getting worse. There has also been much interference with management by workmen; to such degree that in many instances it has been quite impossible to continue operations and plants have been closed. With these conditions there has been a practically total lack of transport for machinery and supplies.

The Future in Russia

As already mentioned there has always been a scarcity of nearly all mining products in Russia, and this scarcity will be greater after the war, for Russia is going to progress rapidly. Education will spread fast, and with the continuation of prohibition the consequent demands of the peasant class for various articles that they did not require before the war will be largely increased. It is possible that there will be a period of expansion similar to that observed in the United States after the Civil War. But, in any event, there is going to be a tremendous demand for mining products, particularly after a stable government shall be established. No one ventures to predict when the revolution will end, and until such time not much can be done in Russia, except in acquiring information or in preliminary preparation for future activities. However, the revolution has caused the offer for sale of numerous good mining businesses, which can be bought cheap by any one who will take the risks due to the possibility that the revolution may continue for several years.

Copper Output Has Not Increased

The copper producing capacity of Russia is about the same as it was just previous to the war, although the country is now producing less than then. A new smeltery has been blown in in the Caucasus, and the rich ores of a Siberian company have been exhausted; so there is no remarkable change. However, there have been developments of copper ore by diamond drilling and otherwise, particularly in the Altai, where on the Zminogorsk concession there has been proved by drilling an orebody about 3000 ft. long and about 20 ft. wide and averaging over 4% copper. The deepest drill hole cuts the ore at a depth of about 500 ft. below the surface and shows over 6% copper in primary minerals. This promises to be a large mine. There are other deposits on the Zminogorsk concession with similar geological conditions that promise also to become big mines. The indications are that the Altai district may be an important source of copper in the future. There is also a content of zinc in the ore, and the advisability of applying the electrolytic process is being seriously considered. The existence of favorable hydro-electric possibilities near the mines is a most favorable circumstance.

PRODUCTION OF COPPER IN RUSSIA

(Long Tons)

	Ural	Caucasus	Siberia	Chemical and Refining Works	Totals
1907	7,418	5,004	1,067	1,030	14,519
1908	8,429	4,821	2,417	881	16,548
1909	8,433	6,492	2,429	631	17,985
1910	10,529	7,602	3,165	895	22,191
1911	12,660	7,956	3,688	894	25,198
1912	17,451	9,597	4,742	1,204	32,994
1913	16,037	9,990	5,592	1,371	32,990
1914	16,560	8,346	5,453	1,394	31,753
1915	16,829	3,648	4,184	811	25,472
1916	15,210	3,927	947	473	20,557

COPPER INGOTS IMPORTED INTO RUSSIA

(Long Tons)

1913	1914	1915	1916
6,032	12,646	41,773	64,516

SELLING PRICE OF COPPER IN RUSSIA

(Cents per Pound)

1896	15.07	1907	22.82
1897	15.40	1908	17.88
1898	16.14	1909	17.74
1899	20.85	1910	18.04
1900	20.59	1911	17.69
1901	19.13	1912	20.74
1902	15.82	1913	20.16
1903	17.43	1914	20.39
1904	17.53	1915	24.16
1905	19.68	1916	38.63
1906	25.26	1917	42.05

Before the war the per-capita consumption of copper in Russia was about 14% that of America, and Russia imported about 20% of all the copper she used. It is obvious that the demand for copper after the war and the revolutions are over is sure to be great and that the mining of copper is going to be excellent business. The accompanying tables give figures of production, imports and prices of copper.

Gold and Platinum

The production of gold has decreased rapidly since 1913, as the accompanying tabulation well illustrates. The official price of gold in Russia before the war was 5.50 rubles per zolotnik[1], or about 40.09 rubles per oz.

[1] 65.83 grains. 7.291 zolotniks = 1 oz. Troy.

In 1915 it was raised to 7.90 rubles per zolotnik and now it is 11.50 rubles per zolotnik, or more than twice its pre-war price. Private trading in gold has recently been done at the rate of about 45 rubles per zolotnik, or about

PRODUCTION OF PLATINUM IN RUSSIA
(Ounces)

1911	185,152	1915	113,090
1912	177,262	1916	166,778
1913	157,800	1917 (estimated)	100,000
1914	155,838		

328 rubles per oz. Even with the stimulation of such high prices there has not been an increase of production; indeed, there has been a fall, which is rather an eloquent commentary on the lack of elasticity of the producing capacity of gold in Russia.

No important discoveries of vein or placer deposits have taken place in the last three years. The phenomenally rich drifting ground in the Lena River region is being rapidly exhausted. A 17-cu.ft. bucket dredge of

VALUE OF GOLD PRODUCTION IN RUSSIAN EMPIRE

1914	$31,500,000	1916	$22,500,000
1915	27,000,000	1917 (estimated)	18,000,000

the California type, to work in ground in the Lena region 100 ft. deep, digging 80 ft. below the surface of the pond, is fabricated but its shipment will be postponed until transport conditions improve. This means that it will probably not begin work before 1920 or 1921.

The Anadir region deposits opposite Seward Peninsula have not proved to be of similar extent or thickness to those of Cape Nome. They seem to be of slight importance.

The accompanying table shows the platinum production in recent years. It is apparent that there was a decrease of production for several years before the war and a sharp decrease since the war began. The platinum placers are being exhausted and no important discoveries of new placers have taken place in recent years. The North Ural is said to have the same rocks that produce platinum in the South, and it is possible that intelligent research there may meet with success. Otherwise it seems probable that there will be a continued decrease of production and an increase of price.

Besides being numerous and complex, the Russian mining laws have not been conducive to active investigation by men of small capital, and as a result there has not been the same kind of prospecting as noted in America. It has also been possible for influential people to get large concessions and to hold them for years with the hope of selling for fantastic prices, but without any intention of living up to the terms of the concessions. This has resulted in large areas being practically closed and entirely unproductive. It seems certain that the mining code will be revised in such a way as will encourage development of the mining possibilities and so that huge concessions will not again be given to the favored few.

There have been serious restrictions against working by foreigners in areas within 100 versts of the coasts and boundaries. This has retarded progress, as, for instance, on the Pacific coast of Siberia, where the existence of gold would have by this time attracted large numbers of practical and skilled Alaskan miners, who would have preferred going to Siberia to returning to America as the Alaskan placers were exhausted. This law effectually closed the most accessible part of Siberia. It is extremely likely that this restriction will be removed in the future.

As a result of the war, the restrictions against the entry and employment of Chinese, Japanese and Korean labor have not been enforced, and it is probable that, especially in Siberia, where there will be a dearth of labor, yellow labor will be more generally used. Chinese are now being employed not only in mining but in other ways. It is possible that the labor situation in Russia, as regards at least a plentiful supply, will be favorable. It is also possible that yellow labor will not become infected with socialistic madness and will serve as an antidote to white labor.

Transvaal Mining in 1917

By H. F. MARRIOTT*

THE year 1917 was the most difficult of the war period for the gold-mining industry of South Africa. The native labor position was increasingly bad, owing chiefly to the recruiting of natives for military work in Europe and to the fact that greater numbers are needed year by year for industries other than that of gold mining. The principal result of this condition was slightly smaller tonnages, and, therefore, reduced yields from some of the mines. Further numbers of the white employees were released for military service, and payments to their dependents became a considerable charge on the mining companies. The cost of all materials increased, and some extensions of plant were held up owing to the delay in getting the necessary machinery. In spite of these difficult conditions, however, the estimated gold output from the Transvaal for 1917 dropped only slightly below the record figure of 1916, a remarkable exhibit considering existing conditions. Every effort was made to maintain a high standard of production—a factor of immense importance at present.

In September, 1917, there were 49 producing companies on the Rand, as against 51 in September, 1916. The two mines that ceased production were May Consolidated, which went into liquidation in April, and the Vogelstruis Estates, which stopped its operations a little later. Thirty-five mines paid dividends in the first half of the year, as against 38 for the corresponding period in 1916, the East Rand Proprietary Mines, New Kleinfontein, and Randfontein Central being those which suspended dividend payments. On the other hand, the position of companies in the Far East Rand improved and the Modder Deep increased its dividend from 30 to 40%. Tables I, II and III show respectively the yield, milling capacity and the labor position in 1917 as compared with previous years.

There was a distinct movement during the year to direct the attention of shareholders to the difference between divisible and working profit. It is maintained

*Consulting engineer, 1 London Wall Buildings, London, E. C., England.

that the published figures taken alone are likely to be misleading owing to the large number of charges over and above working costs, the amount available for dividend being at best about 70% of the declared profit. War and other taxation, increased realization charges,

TABLE I. TRANSVAAL GOLD PRODUCTION

Witwatersrand District

Year	Tons Milled	Value	Value per Ton Milled, Shillings	Outside Mines, Value	Total Value for Transvaal
1884-89	1,000,000	£2,440,000	48.8	£238,231	£2,678,231
1890	730,000	1,735,491	47.4	134,154	1,869,645
1891	1,154,144	2,556,328	44.2	367,977	2,924,305
1892	1,979,354	4,297,610	43.3	243,461	4,541,071
1893	2,203,704	5,187,206	47.0	293,292	5,480,498
1894	2,830,885	6,963,100	49.2	704,052	7,667,152
1895	3,456,575	7,840,770	45.2	728,776	8,569,555
1896	4,011,697	7,864,341	39.2	739,480	8,603,821
1897	5,325,355	10,583,616	39.7	1,070,109	11,653,725
1898	7,331,446	15,141,376	41.3	1,099,254	16,240,630
1899	6,872,750	15,067,473	48.8	661,220	15,728,693
1900	459,018	1,510,131	65.8	.....	1,510,131
1901	412,006	1,014,687	49.2	81,364	1,096,151
1902	3,416,813	7,179,074	42.0	74,591	7,253,665
1903	6,105,016	12,146,307	39.8	442,941	12,589,248
1904	8,058,295	15,539,219	38.5	515,590	16,054,809
1905	11,160,422	19,991,658	35.8	810,416	20,802,074
1906	13,571,554	23,615,400	34.8	964,587	24,579,987
1907	15,523,229	26,421,837	34.0	981,901	27,403,738
1908	18,196,589	28,810,393	31.6	1,147,217	29,957,610
1909	20,543,759	29,900,359	29.1	1,025,429	30,925,788
1910	21,432,541	30,703,912	28.5	1,297,823	32,001,735
1911	23,888,258	33,543,479	28.1	1,498,006	35,041,485
1912	25,486,361	37,182,796	29.2	1,574,765	38,757,560
1913	25,628,432	35,812,605	27.8	1,545,435	37,358,040
1914	25,701,954	34,124,434	26.5	1,463,641	35,588,075
1915	28,314,579	37,264,992	26.3	1,362,469	38,627,461
1916	28,525,252	38,107,909	26.7	1,377,025	39,484,934
1917 (est.)	27,732,436	37,474,854	27.0	1,311,801	38,786,655

and payments under the Miners' Phthisis Act are large items that have to be met after purely mining expenses have been provided for.

Two Important Consolidations

Two important amalgamations of mining groups took place in 1917. In January the Johannesburg Consolidated Investment Corporation purchased Sir J. B. Robinson's interests in the Randfontein Estates, Randfontein Central, and Langlaagte Estates. On July 1 the Central Mining and Investment Corporation took over the administration of the Neumann mines, the chief of which are the Consolidated Main Reef, Main Reef West, Wolhuter, Knight Central Witwatersrand Deep, and the Witbank colliery. The Consolidated

TABLE II. STAMPS AND TUBE MILLS

	Stamps at Work	Tube Mills at Work	Duty per Stamp per Day
1909, December	9,250	148	6.8
1910, December	9,150	184	7.2
1911, December	9,565	244	7.9
1912, December	9,440	277	8.4
1913, December	9,170	278	8.7
1914, December	9,291	294	9.1
1915, December	9,195	314	9.7
1916, December	9,185	313	9.8
1917, August	8,967	323	10.0

Main Reef purposes absorbing the Main Reef West. The latter has not had a successful career as a separate unit, and will have a better chance of prolonging its life under the new conditions.

The Sub-Nigel mine, in the Heidelberg district, continued to give good results, and increased its area by acquiring 500 claims on the Farm Grootfontein. The Oceana Development Co. made arrangements for boring on the southern extension of the Main Reef series eight miles southwest of the Nigel mine.

The position at the East Rand Proprietary Mines became gradually worse; the value and amount of the ore reserves decreased, and the shortage of native labor restricted the output. A great influx of water into the lower levels added to the difficulties encountered. The François cementation process is being employed to dam back the feeders and carry the workings through the water zone and shows every indication of being successful. Development was confined to definitely payable areas, and every effort is being made to continue until the value of the southern ground can be proved.

The Simmer & Jack Proprietary Mines added to its life by the purchase of 40 claims from the Simmer Deep. This ground, it is estimated, will produce a net profit of £100,000 over two years. At the City Deep, Ltd., Butters slimes filters having a capacity of 45,000 tons per month were installed.

State Mining and the Far East Rand

The Far Eastern Rand, which continues to hold first place in prospective interest, came still further into prominence in 1917. A royal commission, appointed to inquire into the question of state mining, was chiefly concerned with this district and issued its report early in the year. The majority came to the conclusion that greater profits would accrue to the state under conditions of private enterprise than would be obtainable by direct government control. The minority report urged that the state should itself immediately begin operations in the Far Eastern Rand. The government accepted the majority report and proceeded to offer several areas in the Far Eastern Rand for tender. The interesting evidence of Mr. Kotzé, the government mining engineer, given before the commission, is worthy of note. He was not in favor of mining by the state, but said that he could see no limits to the possibilities of private enterprise in the Far Eastern Rand. From Mr. Kotzé's statement that his estimate of a yield of £450,000,000 from the Far Eastern portion is conservative, it is evident that the Rand is by no means played out. He expects the Modderfontein farm alone to produce £135,000,000.

Eight of the nine companies producing in the Far Eastern Rand in September, 1917, are dividend payers. The crushing capacity of the plants is being increased. The Geduld Proprietary Mines, Ltd., is now able to treat 40,000 tons per month. Extension of the New Modderfontein Gold Mining Co.'s plant from 50,000 tons to 90,000 tons per month is well forward, and operation on the enlarged basis is expected by the middle of 1918. The main hoist for the circular shaft, which has been the chief cause of the delay, is nearing completion.

An important event in 1917 was the beginning of crushing operations at Springs Mines in February. This was the first addition to Rand producing companies since the Modderfontein Deep first dropped its stamps in December, 1914. The Springs reduction plant has an annual capacity of 360,000 tons. The amount of payable ore exposed to the end of September was 46.6% of the total development on the reef.

Brakpan Mines, Ltd., obtained the lease of the 1812 claims, being the remainder of the Brakpan farm, offered by the government for tender at the end of 1916. That company also acquired the 424 claims of the Farm Schapenrust, and the effect of these additions will be to double the life of the mine. The capacity of the plant is to be increased at an early date from 60,000 tons to 75,000 tons per month, with a view to a further increase in five years' time to 120,000 tons per month.

The tender of the Central Mining and Investment Corporation, Ltd., for the area of 651 claims in the Farm Modderfontein, adjoining Modderfontein B mine on the east, was accepted by the government at the end of 1916. An agreement has since been confirmed between the Rand-Klip and Cloverfield companies and the Central Mining and Investment Corporation whereby the three properties are combined in one undertaking under the name of the Modderfontein East, Ltd. The total nominal capital of the new company arranged for is £1,500,000, of which 340,459 shares have been issued for the Rand-Klip and Cloverfield properties, and working capital to the extent of £1,168,-080 is provided for. Work was begun on the property early in 1917, and the sinking of the two circular shafts is progressing.

In June the government offered four new areas in the Far Eastern Rand for tender. These comprised a total of 9248 claims on Springs, Geduld and De Rietfontein farms. The successful competitors were: Johannesburg Consolidated Investment Corporation, for the Springs area; Springs Mines, Ltd., controlled by the Consolidated Mines Selection, Ltd., for the East De Rietfontein area lying to the south of their property. The remaining two areas were not allotted.

New System of Taxation

A new system of taxation was considered by the Union government during the year. Under this scheme the war levy will be withdrawn, and a new tax substituted which will apply to other companies as well as mines. A 5% tax is to be levied on company incomes, and also a dividend tax of 7½%. During the war the gold mines will pay 10% dividend tax. Other companies will be subject to a 25% excess-profits tax during the war and for six months afterward. Gold mines will be exempt from this tax.

TABLE III. LABOR EMPLOYED IN TRANSVAAL GOLD MINES

	Whites	Natives	Native Death Rate per 1,000
1910	25,376	191,784	35.72
1911	25,108	194,286	34.04
1912	24,334	206,121	28.83
1913	22,797	162,181	26.61
1914	21,834	177,291	18.35
1915	22,910	222,735	19.87
1916	23,074	206,852	17.17
January, 1917	23,010	201,380	
March	23,243	204,788	
May	23,072	196,723	15.68(a)
July	22,857	186,064	
August	22,761	183,525	

(a) For 12 months ended August, 1917.

The long-outstanding question regarding the ownership of the mining rights underlying the bewaarplaatsen was settled at the end of March, 1917, by the passing of the Bewaarplaatsen Bill. Nineteen-fortieths of the moneys which were received by the Crown were ceded to the registered owners of the surface, and future income from the same source is to be divided, eighteen-fortieths going to the owners of the surface and the remainder to the government.

The Vaal River water-supply scheme, sanctioned in 1916 in modified form, is being proceeded with, and work on the barrage at Vereeniging was begun.

The following points of mechanical and metallurgical practice will be of interest: Nissen stamps, as now erected, crush 26 tons a day through a mesh of three holes to the linear inch. Amalgamating plates are now made stationary, but are adjustable as to angle; they are placed in a separate house below the tube mills. Classification of sands and slimes has been made practically perfect, there being under 1% of slimes in the sands-treatment tanks in the cyanide works.

Central pumping stations underground are equipped with centrifugal pumps; the larger units are designed each to lift 60,000 gal. per hour to a vertical height of 2300 ft.; they are driven by electrical power, the consumption being 0.57 of a unit per 1000 gal. per hour per 100-ft. lift. The Ward-Leonard system is generally adopted for hoisting units of more than 2000 hp. Progress is being made in the standardization of machinery in use on the mines, thus reducing the cost equipment and repairs to all consumers of types of plant which are in general use.

Labor Agreements and Working Conditions

Various new agreements with regard to labor were drawn up during 1917. In January a committee, formed under the Mines Department, was appointed to consider the abolition of the contract system of mining on the Rand. The report did not favor the abolition of the contract system, but recommended several improvements safeguarding the miners' interests and confining contract work to experienced men, with a minimum rate of pay somewhat below the current day's pay rate. As a result of negotiations between the Transvaal Chamber of Mines and the miners' union the following points were agreed to: A minimum wage according to experience. A working week of 48½ hours, bank to bank, and an increased war bonus, the agreement to be binding until three months after the declaration of peace. The government undertook to establish and administer a central labor exchange.

The "safety-first" campaign made decided progress during the year, and the publications are now also being issued in the Taal for the Dutch-speaking miners. The steps thus taken to improve the education of the miners in carrying out their work efficiently are proving successful.

Many schemes for improving underground work and organization were evolved in 1917. The Central Mining Rand mines group offered a bonus of £500 for distribution among those putting forward the most deserving suggestions, provided that these are of use to more than one particular mine. The 1916 competitions, organized by the Rand Mutual Assurance Co. in connection with the reduction of mining accidents, resulted in the New Primrose and New Unified obtaining the best absolute records, and the Ginsberg, Luipaard's Vlei and Witwatersrand Deep the highest marks in the competition for the highest proportionate improvement.

The medical-examination bureau, established under the Miners' Phthisis Act of 1916, did good work in 1917. It was able to define and limit the disease and to correct many exaggerated ideas held regarding its severity and extent. Efforts are being made to find surface employment on the mines for all cases of silicosis contracted in the country. Experiments were continued during the year for rendering the natives immune from pneumonia, and the research work being carried out with respect to vaccine treatment should prove of world-wide benefit.

After investigations and experiments carried out during the last three years, the process of spraying the surface of the sand dumps with black mud has been found to be the most efficacious means of preventing drift. The necessary covering can be applied at small cost.

In regard to the importation of mining supplies, every effort was made in 1917 to relieve overseas transport and to reduce the claims on home manufactures. The total amount of supplies imported was less than 6000 tons per month. Local industries were utilized as far as possible, and the production of shoes and dies from scrap steel and iron was successfully accomplished. The greater part of the explosives required for mining purposes was obtained in the country in 1917, and prices compared favorably with those prevailing in other mining centers. Economy was practiced in the use of higher grade explosives in order to free more glycerine for war purposes.

The position of the diamond industry continued to improve throughout 1917. In the half-year ended June 30 the Transvaal output was 491,410 carats, the value being £865,961. Of this 459,646 carats came from the Pretoria district. At the end of 1916 the Premier company joined the selling syndicate, so that the disposal of the South African output is now under one control. The number of natives in the diamond mines at the end of September was 4791, as against 6527 in September, 1916.

The Messina copper mines showed satisfactory results throughout 1917. Tonnage of ore reserves increased, but was accompanied by a drop of 5% in value. A dividend of 1s. per share was paid in June. In regard to tin mining, the results obtained from the Zaaiplaats and the Rooiberg mines during the early part of 1917 were disappointing. In order to supplement the ore reserves of the latter mine, the mineral rights of the adjoining Farm Blaauwbank were acquired. It has been stated that a deposit containing nickel was found recently on the property.

Australasia in 1917

By W. P. GEARY*

THE mineral production of Australasia declined in 1917, as it has steadily for the last few years, and unless new deposits are discovered the industry is likely to continue on the downgrade. Present output is chiefly from the Broken Hill mines, in New South Wales; Mount Morgan, in Queensland, and Mount Lyell and Mount Bischoff, in Tasmania. These mines cannot last indefinitely and the urgent need for new mineral fields is generally admitted. If substantial reward were offered for their discovery, it would lead to systematic prospecting. As a further aid, it has been suggested that efficient geologic surveys would prove of great value.

Gold Production Diminishing

The gold yield still continues to diminish, the accompanying table indicating the comparison between the production in 1916 and that in 1917. Western Australia ranked as the largest producer in the last two years, al-

AUSTRALASIAN GOLD YIELD IN 1916 AND 1917

	1916 Fine Oz.	1917 Fine Oz.
Western Australia	1,061,398	970,498
Victoria	256,643	204,708
Queensland	215,162	182,440
N. S. Wales	108,145	85,092
Tasmania	15,790	15,000
South Australia	5,016	5,000
Totals	1,662,154	1,462,738
New Zealand	292,620	280,000
Grand totals	1,954,774	1,742,738

though its output was below that recorded for 1915. The important producers there were the Great Boulder, Ivanhoe Gold, Associated Gold, Sons of Givalia and Edna May Central. In Queensland, Mount Morgan continued to be the premier gold producer; Mount Boppy, which has been the leading gold mine in New South Wales, ceased production in February, 1917, a new shaft being necessary to continue the profitable working of the mine.

*Department of Mines, Sydney, Australia, N. S. W.

In Tasmania, the Tasmania Gold mine operated at Beaconsfield; in New Zealand, the Waihi Grand Junction and the Waihi Gold were the principal producers; the latter mine, having about 1,500,000 tons of payable ore developed above the 1300 level, suspended shaft sinking and development below the 1450-ft. level, owing to difficulty in securing labor and supplies.

Copper Production

The refining capacity for copper in Australia was about the same in 1917 as in the previous year. The enlargement of the plant at Port Kembla more than compensated for the closing down of the English & Australian Copper Co.'s establishment at Newcastle. To take care of the non-auriferous copper material thus released, the Electrolytic Refining and Smelting Co., at Port Kembla, had to add to its plant. Production of refined copper of Australasia will probably be about 37,500 long tons, divided as follows: Queensland, 20,000; South Australia, 6500; Tasmania, 5000; New South Wales, 4750; West Australia and Papua, 1250 tons.

In Queensland, Mount Morgan continued to be the leading producer of copper, with an output of about 8000 tons; this production will be closely followed or may even be exceeded by that of the Hampden Conclurry. Smaller producers were Mount Elliott and Mount Cuthbert; the former completed a small refinery in September at Bowen. In South Australia, Wallaroo & Moonta was responsible for practically all the production, as was Mount Lyell in Tasmania, where the output showed a decline. In New South Wales the Great Cobar, with the aid of a government loan of £40,000, produced about 2500 tons of copper and returned £20,000 of the loan; the government extended the railroad to the C. S. A. Mines and will build a 10-mile spur to the Mount Hope, both of which mines are in competent hands. In Papua, pyritic orebodies of promising dimensions were being opened on one or two properties.

Silver, Lead and Zinc

The silver, lead and zinc production in the Broken Hill field was greatly retarded during the period under review on account of local industrial troubles, but more particularly by general strikes, which started in August and lasted for two months. The mines are again at work, however, and conditions at the end of the year were about normal. The rise in the price of silver was of considerable interest to this district, due to the additional income thus made possible. The Broken Hill Proprietary Co., for the half year ended Nov. 30, 1916, the latest report issued by the company, mined 110,276 tons, compared with 66,423 tons for the previous half year. The mill handled 97,630 tons of crude sulphide ore, producing 17,065 tons of lead concentrates, assaying 58.73% lead and 28.12 oz. silver per ton. The zinc-flotation plant was put into commission toward the close of this period, and treated 13,232 tons of tailings for the production of 2805 tons of zinc concentrates, assaying 47.41% zinc, 13.02 oz. silver and 5.72% lead per ton.

The ore raised by the Broken Hill South Co. during the half year ended June 30, 1917, amounted to 121,433 tons of an average assay of 13.7% lead, 6.6 oz. silver, and 13.3% zinc. The output for the previous six months totaled 157,059 tons. The North Broken Hill Co., for the first half of 1917, treated 111,290 tons of ore, producing 22,045 tons of lead concentrates.

The Tin Output

The production of the Mount Bischoff Tin Co., Tasmania, for the first half year was 52,565 tons of ore and 219 tons of tin concentrates. The smelting works treated 226 tons on behalf of the company and 1250 tons for the public. The yield of tin was 139 tons and 872 tons, respectively. The Briseis Tin Co., at Derby, Tasmania, for the year ended December, 1916, treated a total of 825,000 cu.yd. of drift and overburden, with a return of 466 tons of black tin, equal to 331 tons of metallic tin. The Pioneer Tin Mining Co., Tasmania, during the year ended June, 1917, treated 894,700 cu.yd. of material and delivered 471 tons of tin, the cost figuring out 4.487d. per cubic yard.

The tin production of Queensland for the first nine months of 1917 amounted to 868 tons, valued at $558,630. The rock treated from the Vulcan mine, Irvinebank, Herberton district, amounted to 5691 tons, giving a return of 110 tons of black tin valued at $50,145. The production of this mine was the greatest from the district, although the smallest record that it has made for many years.

In New South Wales operations in the Tingha and Emmaville districts were continuous. The Tingha plant of the Copes Creek Central Tin Dredging Co. treated 74,260 sq.yd., yielding 43¼ tons of tin. The two plants at Skeleton Creek, Glen Innes district, treated 86,471 tons of material, yielding 26 tons, and 74,189 cu.yd., for 28 tons of tin, respectively. For the half year ended July 31, 1917, the output of the Y-Water Tin Co. reached 97.86 tons of black tin.

In Victoria, the Cock's Pioneer Gold and Tin Mines, Eldorado, had a satisfactory performance for the half year ended May 31. The yield was 55 tons of tin concentrates and 3784 oz. of gold. The quantity of tin produced in Western Australia in 1916 was 463 tons. From the Greenbrookes tin field, it was 281.74 tons, while the Pilbara field produced 153.17 tons.

Coal production from the state coal mine in Victoria amounted to about 372,000 tons in 1917, a decrease from the 433,522 tons mined in 1916, much time having been lost by the labor strike, the curtailment of production affecting other branches of the mining industry. In Queensland, the 1916 production was 907,727 tons and the first five months of 1917 showed a 10% increase over the corresponding period of 1916. Tasmania made a small production; in 1916 the output was recorded as 55,575 tons.

The Asbestos Industry

AN ACTIVE and continuous demand characterized the asbestos industry in 1917 and, with the phenomenally high prices, strenuous efforts were put forth to obtain the maximum production. In the Thetford and Black Lake districts of Quebec, which produce about 85% of the world's supply of asbestos, the 1917 output was approximately 140,000 short tons, an increase of about 12% over the 1916 production, which was 133,339 tons, valued at $5,182,905. The major amount of this production was used in the United States, although the war demand for the higher grades of asbestos gave to European shipments a higher value. Labor supply was limited but conditions were fairly satisfactory, owing partly to a local rivalry between two unions and partly to the action of the producing companies in advancing wages proportionately to the advance in prices of asbestos. Prices have doubled since the beginning of the war and range from $15 per ton for the shorter grades to $900 for long fiber, although certain exceptional sales have been made as high as $1700 per ton. Noteworthy features of 1917 were: The installation of the drying and storage systems of the Asbestos Corporation of Canada, whereby the difficulties formerly experienced in getting the ore sufficiently dry to permit of maximum extraction, were reported to be solved; the adoption of the milling system of underground mining by the Jacob's Asbestos Co., to obviate lost working time, difficulties of removing the atmospheric moisture, and to permit of the more economical working of the ore deposits, and the discovery of another asbestos field in the Township of Ireland, where a modern reduction plant is now being installed by the Bennett-Martin Asbestos and Chrome Co.

In the United States, asbestos was produced in 1917 in Arizona, California, Idaho, Georgia, Vermont and Virginia. At Washington, Calif., the Washington Asbestos Mines Co. secured a large deposit of chrysotile asbestos and is mining and milling an average of 15 tons per day.

Rhodesian deposits were operated by the Rhodesian and General Asbestos Corporation, a new company registered in Rhodesia with a working capital of £30,000. The properties are situated in Victoria, Belingwe and other districts. Regular output was maintained.

Graphite in 1917

THE supply of graphite in the market during 1917 was sufficient for all demands, and, aside from temporary embargoes, mostly in connection with transportation, the same sources continued to furnish the world with graphite as before the war. Domestic production naturally increased to meet the demand, and while certain new sources of supply sprang into existence, the principal among which was Alabama, they were mostly the result of increased development in and about the same fields that supplied the world in the pre-war period. New deposits were investigated and developed, but comparatively little marketable material resulted.

The chief reason for the increase in the price of imported material was the high cost of transportation, and domestic graphite naturally rose to comparatively high levels, especially the crystalline or flake varieties. The amorphous graphites did not increase nearly to the same extent, which can be accounted for by the fact that whatever increased demand there might have been for this quality was taken care of by supplies mined on this continent.

Production in United States

Alabama's output is expected to more than double that of 1916, which is remarkable because Alabama's 1916 production was 50% greater than in 1915. In Clay County, and to a lesser extent in Coosa and Chilton Counties, in the eastern part of the state, graphite mining was greatly stimulated by the high prices. The activity centered around Ashland and Lineville. There were at the end of 1917, as reported by William F. Prouty, of the Alabama Geological Survey, about 60 incorporated graphite companies in the flake-graphite region; of these, 30 were producing hourly approximately 400 tons of ore, which yields about 16,000 lb. of refined graphite per hour. Many of the mills were running night and day.

New York's production for 1917 is estimated by D. H. Newland at 5,500,000 lb. of flake graphite, representing a gain of nearly 50% for the 12 months and is about double the normal total of earlier years. Mr. Newland will review New York's graphite industry in a subsequent issue. The only important new producer was the Black Mountain mine of Hooper Brothers, near Whitehall, which started operations last summer. This is situated in the range of mountains between Lake Champlain and Lake George, west of Whitehall. The vein, according to G. H. Hooper, outcrops for nearly a mile in length with a thickness varying from 16 to 50 ft. and dips 25°, assays taken across the vein analyzing from 5% to 7.4% carbon. The character of the flake is similar to that of other graphite deposits in the vicinity of Lake George and is noted for its special adaptability to lubrication. The 100-ton plant was run at one-half capacity only during the time required to put in the developing tunnel. In December the plant was operating at full capacity and producing four tons daily of a high-grade lubricating flake, guaranteed to run over 90%. The finishing and manufacturing plant has good shipping facilities, the barge canal and the main line of the Delaware & Hudson R.R. being on either side.

Texas graphite deposits made no production of commercial importance but installation of a new plant was started at the old property of the Texas Graphite Co., in Burnet County, this deposit now being under the control of the Southwestern Graphite Co. No production was made here during the year. The only important producing property in the state was the Dixie Graphite Co., at Llano. J. Warren May, general manager of the latter, reports that the plant has been practically rebuilt since last August. The ore is now put through crushers, Lane mills and screens, then over flotation machines, producing concentrates of about 50 to 60% carbon, which are dried, and the graphite after being put over buhrs and screened is ready for bagging. The mine has three levels at 30, 50 and 100 ft. All three are being worked, the ore on the top running about 15%, the next level, about 25% and the lowest, 35%. The graphite is a mixture of amorphous and flake.

Respecting production of artificial graphite in 1917, Orrin E. Dunlap, secretary of the Acheson Graphite Co., Niagara Falls, N. Y., reported that there were few events of importance, the story being told in the statement that production was slightly increased, while on some grades there was a slight increase in price due wholly to sharp increases in the cost of raw materials and labor.

Production in Quebec and Ontario

Shipments from graphite mines of the Province of Quebec, Can., during the first 10 months of 1917, were reported by a correspondent at 376,390 lb., valued at $75,778. Although the Quebec graphite industry dates back to 1847, it cannot be said to be established on a satisfactory basis. The deposits which are worked are of sillimanite, gneiss and crystalline limestone, containing flake graphite disseminated through the rock. The concentration to the required standard, of over 90% carbon for crucible graphite, offers great difficulty. Yet for the last 12 years there has been an annual production which has varied in value from a minimum of $165 in 1908 to $75,000 in 1916. The year 1917 probably gave a record figure in graphite production in the district. The largest operators evolved a satisfactory method of concentration, but circumstances militated against the industry, such as scarcity of labor, abnormal price and shortage of coal and an unusually rainy season, which put the roads in such a condition as to preclude hauling of the ore to the mills where the concentrators were not near the mines. The prices obtained for the Quebec graphite as reported by Th. Denis, superintendent of mines in Quebec, were the highest on record, the best quality flake graphite bringing as high as 16c. per pound.

Production of refined graphite in Ontario in 1917 was estimated at about 4000 tons by Thomas W. Gibson, Deputy Minister of Mines, as compared with 3446 tons in 1916. Mr. Gibson will review the graphite industry in Ontario in a subsequent issue.

Shipments of crystalline and amorphous grades in considerable quantity were made from Mexico, especially in the latter part of 1917. Madagascar graphite production, greatly stimulated in the last few years, is

estimated to have amounted to between 16,000 and 20,000 tons during 1917.

The market prices for various grades were dependent principally upon transportation conditions. The prices for Ceylon graphite, ex-dock, New York, were approximately as follows: No. 1 lump, 28 to 30c. per lb.; No. 1 chip, 19 to 21c. per lb.; No. 1 dust, 11 to 12c., which figures represent about the level maintained during the year. These compare with pre-war prices as given by the U. S. Geological Survey as follows: 1913, 4.9c.; 1914, 4.5c.; 1915, 6.4c.; 1916, 12c. The prices for American flake varied from 12 to 18c.—the latter figure being for No. 1 flake, 90% carbon or better and of uniform grade, in carload lots—which prices are approximately three times the price before the war and from 3 to 4c. in advance of the prices a year ago. Amorphous graphite from Chosen was quoted at different times at between 2c. and 3c. per lb., the latter figure being in the main, nominal. Freight rates on Chosen shipments reached as high as 200s. during the year.

Unusual Ores and Metals in 1917

THE commercial position in 1917 of some of the unusual ores, minerals and metals affected is reviewed in the following interesting notes communicated by the Foote Mineral Co., of Philadelphia:

Bismuth—The chief domestic source of this metal is from the refining of lead. The abnormally high prices of 1916, which during one period reached $4 per lb., dropped to about $3.25 toward the end of that year and remained comparatively firm at this price during the first half of 1917. Apparently the price of bismuth is not affected by supply and demand and it is understood that quotations are arbitrarily fixed by a European syndicate working through agents in this country. Prices for the last quarter of 1917 declined still further, due to importations of crude bismuth from South America by independents. Present quotations for pure metal range according to quality from $2.65 to $3 per lb. The activities of independent South American producers of crude metallic bismuth indicate still further recessions in price for the coming year.

Cerium—Cerium products remained comparatively firm during the year. As is known, the chief source of cerium is the byproduct from the treatment of monazite sand in the extraction of thorium for incandescent mantles. The two most important products of cerium are metallic cerium (misch metal) and cerium oxalate. The former is really an alloy of the metals cerium, lanthanum, didymium, etc. It generally carries about 50% cerium, the remainder being other rare-earth metals of the same group or related groups. This metal when further alloyed with about 30% metallic iron produces what is variously known as pyrophoric alloy, ferrocerium, auermetall, etc. The manufacture of ferrocerium is controlled by foreign patents and the production of this alloy is practically in the hands of one manufacturer in this country. The price of ferrocerium remained firm throughout 1917 at $25 per lb. for large contracts. No figures are available as to the annual production of ferrocerium but it is believed to equal several thousand pounds per month. The principal use of ferrocerium is as an igniter in such device as pocket cigar lighters, lanterns, mine lamps; also in hand grenades, projectiles, etc. The price of cerium metal remained practically firm. In addition to its use in the manufacture of ferrocerium, cerium mixed metal is also employed to a limited extent as a reducing agent in the production of metallic zirconium, thorium, etc., and its applications in this direction are likely to increase. The price of cerium oxalate remained practically firm at 90c. per lb. throughout the year. Strictly speaking, this is not a pure cerium oxalate but is a mixture of the oxalates of rare earths of the cerium group.

Chrome Ore—Prices for chrome ore remained steady during most of 1917. The scarcity of high-grade ore began in October and at the end of the year it was at a premium. Inadequate labor at the mines and poor transportation facilities combined to raise the price, at least for the winter months.

Manganese—The demand for metallurgical manganese ore increased during the spring of 1917. The import difficulties were plainly realized and, in order to insure a sufficient supply, large users advanced the price, as evidenced by the Carnegie schedule, and also began looking for domestic ore. Most buyers satisfied their requirements by the end of July, and being certain of an adequate supply of ore at this higher price insisted on obtaining a high-grade ore. From that time it was relatively hard to sell ore low in manganese or high in silica. However, it proved practically impossible, under new contracts, to secure any appreciable quantity of 48% ore from abroad at prices lower than $1 per unit and consequently the price of metallurgical ore remained fairly constant, although tending to advance slightly during November and December.

Palladium—The enormous consumption of platinum by munition plants compelled domestic users of this precious metal to search for a satisfactory substitute. This has been found in another member of the platinum group; namely palladium. Metallic palladium resembles platinum in many respects, but as it is even more expensive than platinum in its pure state, it was found necessary to alloy it with one of the other noble metals, gold being found the most satisfactory. Several patented alloys of gold and palladium, carrying about 80% of the former, are now on the market and are reported by users as being highly satisfactory. During the early part of the year the price of palladium was approximately the same as that of platinum, but as it became more difficult to secure the latter metal, the price of palladium advanced to $115 per oz. during the middle of July and to $125 in September. The market closed[1] at

AVERAGE MONTHLY PRICES OF PALLADIUM[1]

(In Dollars per Ounce)

	1917		1917
January	73.00	July	113.60
February	88.32	August	120.00
March	88.05	September	123.44
April	93.70	October	121.92
May	104.00	November	126.87
June	108.29	December	130.60
Year			107.65

[1] "Engineering and Mining Journal," quotations.

$130@135 with a brisk demand. Increasing scarcity has lately been noted, owing to foresighted consumers covering their requirements for 1918, and the bulk of the production was sold far ahead.

Selenium—This element, which is secured mainly as a byproduct from the electrolytic refining of copper and is used principally in manufacturing ruby glass for railway signals, etc., remained firm at the price of $1.20 per lb. during the first half of 1917. During the last half there was a greatly increased demand in the glass trade and at the close of the year the price had advanced to $2.60@$3 per lb. according to quality.

Strontium—The sharp rise in price for strontium ore during March and April was due principally to labor troubles and a British embargo at that time. Following a decline in market value when the latter condition was relieved, the price of ore advanced, owing again to difficulty in obtaining high-quality material from abroad. Some quantities of domestic ore were developed and this helped to relieve the pressure. The nitrate almost imperceptibly declined, indicating the disparity in values between the chemical product and the raw material. Since the price of strontium nitrate was so far in excess of its pre-war value, sufficient leeway for satisfactory profit was available without regard to the price of the ore.

Thorium—Owing to the greatly increased demand and the difficulty of obtaining Indian monazite, which is subject to British Government regulation, the price of Brazilian monazite steadily increased due to inadequate shipping facilities. Thorium nitrate, on the contrary gradually fell in market value, although the demand remained strictly normal. This condition was brought about chiefly by the growing competition of manufacturers of the nitrate.

Titanium—The scarcity of labor and excessive demands of the Allies prevented any large importations of rutile concentrates (native dioxide of titanium) in 1917. Early in the year the ore was selling for $95 per net ton but at the end of the first quarter the price increased to $120; at the end of the first half, $200; and by the end of 1917 the ore sold for $240 per ton with only small lots available. The absence of any important domestic production had a tendency to advance the price of the mineral and many consumers were compelled to manufacture their titanium products from ilmenite, which sold from $15 to $25 per ton, depending on the percentage of titanium dioxide present. The highest grade of ore, in the form of concentrates, contained as much as 50% TiO_2. There is little prospect of a resumption of any importations on a large scale until late in 1918. In the meantime, it is hoped that the present high prices will stimulate the development of American deposits.

Uranium—Prior to the beginning of the war, the production of uranium ore (carnotite, carrying 2% U_3O_8) was fairly brisk in Colorado and Utah. Most of this ore was exported to Germany for its radium content. Cessation of exports caused a slump in the market and as a result many small mines were compelled to close down. This condition has practically existed since 1914, but the mining of uranium ore was slightly stimulated when the Government established an experimental plant at Denver for the extraction of radium salts. The price remained fairly firm throughout 1917, ranging from $50 to $60 per unit or $100 to $120 per net ton for ore carrying a minimum of 2% U_3O_8. Black uranium oxide, which is a byproduct in the treatment of carnotite, also remained firm throughout the year at the price of $3.25 per lb., guaranteed 96% U_3O_8. No large importations of pitchblende or samarskite were noted.

Vanadium—The price of ferrovanadium and vanadium salts remained fairly firm throughout 1917 with a noted upward tendency during the last quarter owing to the large demands of the Government. Ferrovanadium ranged in price, according to quality, from $2.75 to $3 per lb. of contained vanadium metal, for an alloy carrying from 30 to 35% metal. During the last quarter this price advanced as high as $7.50 per lb. of contained metal, with but small stocks available. Vanadic acid, ammonium metavanadate and vanadate of iron fluctuated but slightly in price during the year: C. P. vanadic acid sold for $11 per lb. of contained V_2O_5; 85% vanadic acid at $1.20 per lb. of V_2O_5; ammonium metavanadate at $7 to $7.50 per lb. according to quality; vanadate of iron, containing 25% V_2O_5, at 80 to 90c. per lb. of vanadic oxide contained.

Zirconium—During the first half of 1917 "Zirkite," the principal ore of zirconium, sold for about $120 per net ton in carload lots. This price during the last quarter declined to $100 per ton, due mainly to the improvement in shipping conditions. It is worthy of note that this decline in price was made in the face of largely increased demands for this new refractory, which is now being used on a commercial scale in many of the better known types of electric furnaces. Extensive experiments were conducted under the direction of several Government experts and it appears that "Zirkite" will soon be classed among such highly refractory materials as magnesite, chromite, alundum, etc. The ore as mined carries from 75 to 80% zirconium dioxide and is the basis of "Zirkite cement," "Zirkite" pulp and when chemically refined, affords "Zirkonalba," white oxide, carrying 99% and over of zirconium dioxide.

Magnesium in War Work

The magnesium industry in the United States owes its start to the European war, which cut off the supply from Germany, practically the only source, prior to the war, of the magnesium used in this country. The result was that the price rose to a prohibitive figure, causing many concerns to discontinue the use of the metal. In 1915 the manufacture of magnesium was started by several companies, including the General Electric Co., at Schenectady, N. Y.; the Norton Laboratories, Inc., first at Nashua, N. H., and later at Lockport, N. Y.; and the Electric Production Co., New York. The Aviation Materials Corporation, Niagara Falls, N. Y., and the Magnesium Manufacturing Corporation, Rumford, Me., began production in 1916. In January, 1917, a new company, the American Magnesium Corporation, of Niagara Falls, N. Y., was formed to make magnesium and its alloys. With it was merged the Aviation Materials Corporation. The new corporation is probably the largest producer of magnesium in the United States. The General Electric Co., it is understood, is no longer an active producer, the price of the metal having fallen so that manufacturing it is no longer so attractive a business. The price is now approaching that which was

asked before the war, due to the fact that it is being manufactured in comparatively large quantities. In small lots it is bringing not more than $2 per lb. and very much less in large quantities.

The principal use of magnesium, according to an official of the American Magnesium Corporation, is for alloying with aluminum for aëroplane parts, where lightness is important. By the proper combination of magnesium, aluminum and other metals, in small quantities, an alloy can be produced which will reduce the weight nearly one half below that of No. 12 aluminum. The so-called "magnalium" alloys belong in this class and contain less than 2% of magnesium. Such an alloy is duralumin, containing aluminum, magnesium and copper, with a density of 2.8, nearly that of pure aluminum, and with a strength nearer that of soft steel. Much of the framework of Zeppelins is made of duralumin.

Magnesium is being used to a greater extent as a deoxidizer and scavenger for copper, brass and bronze, and a new alloy has been prepared for such use in the production of high-grade tool and alloy steels. Magnesium is also largely utilized in making light-bombs and flares for night attacks on European battle fields.

Pyrite in 1917

BY THE WAR MINERALS COMMITTEE
William Young Westervelt, Chairman

Practically all of the pyrite consumed in the United States is used in the manufacture of sulphuric acid either for explosives or for fertilizers. The total supply of pyrite in 1916 was approximately 1,650,000 long tons, of which 1,100,000 was imported from Spain and Portugal, 150,000 came from Canada, and 400,000 tons represented the domestic production. The estimated supply for 1917 was about 1,500,000 long tons, of which 700,000 came from Spain, 300,000 from Canada, and 500,000 from domestic production.

SHIPS DELAYED ONLY SIX TO EIGHT DAYS BY CARRYING PYRITE INSTEAD OF RETURNING IN BALLAST

The over-sea import of 700,000 tons from Spain in 1917 indicates the movement which is of most concern. This pyrite is imported in ships which would otherwise return in ballast to this country either from Italian ports or from England. The latter may take a cargo of coal to Spain, thence returning to the United States. The loading facilities at Huelva, the chief export point, are now good, and the estimated loss in ship time due to carrying a cargo of pyrite instead of returning in ballast is from six to eight days. A large part of this time is represented in unloading in American harbors. The actual ship time in moving the pyrite, however, is not the only factor to be considered. The Spanish mines must be supplied with coal either from the United States or from England. The import figures for pyrite show a decrease of 400,000 tons of over-sea import in 1917 and indicate the increasing difficulty and uncertainty of such movement.

SULPHURIC-ACID REQUIREMENTS

Domestic production of sulphuric acid, measured in terms of 50° B, increased from 3,800,000 short tons in 1914 to 4,200,000 tons in 1915, and to 6,300,000 tons in 1916, and was estimated at 7,300,000 tons in 1917. Thus the war demand more than doubled the production of sulphuric acid and enormously increased the amount of raw materials required. This increase was met mainly by an increased production of sulphur in this country.

POSSIBLE INCREASE IN DOMESTIC SUPPLY

After a complete survey of the principal pyrite districts of the United States, it seems probable that domestic production could be increased by almost 100% within six months' time. Mining development is already partially made and the increase will represent in the main an extension of operations already under way. This would mean from 400,000 to 500,000 long tons of new production which would run from 40 to 45% sulphur, as compared with 46 to 50% sulphur in the Spanish material. The production would come principally from Georgia, Alabama, Virginia and Missouri. It would be relatively close to the market, particularly for the fertilizer industry of the South. Several hundred thousand tons additional pyrite might be secured at short notice from points further west in Colorado, Utah and Arizona, in case of extreme necessity. In addition to pyrite there are vast deposits of pyrrhotite containing approximately 30% sulphur, conveniently situated in the Southeastern and Eastern states, which are ample to supply the entire demand of the country's sulphuric-acid industry but require modification of acid manufacturers' equipment and practice, as yet installed at but few plants.

PROBLEM OF STIMULATING PRODUCTION

Pyrite mining on a large scale is a new undertaking in this country. Mining and milling methods need improvement. Several of the new mines have shut down temporarily because of lack of labor, fuel and supplies. The additional output indicated, which is necessary to eliminate the Spanish import, cannot be secured unless constructive assistance and encouragement are given to pyrite mining in this country. Above all, steps should be taken to stabilize price conditions for a reasonable period of time in order to relieve the uncertainty which is now preventing private companies from carrying on adequate development.

If Spanish imports are discontinued and domestic production is not stimulated, the only alternative is to cut the consumption of sulphuric acid and sulphur along certain lines. For acid, this would mean a curtailment in our fertilizer industry, in our petroleum refining and in other industries. For sulphur, it would mean a curtailment of the sulphur for sulphite wood pulp, or in the supply of sulphur required by our Allies.

COST OF DEVELOPING DOMESTIC INDUSTRY RELATIVELY SMALL

The factor of complete supply and safety in raw materials for sulphuric acid is relatively small. All things considered, it is comparatively easy to double domestic pyrite production, and, with the additional use of sulphur and Canadian pyrite, to be able to dispense entirely with the imports from Spain. The cost of making this development would be relatively small when compared with the expense involved in chartering ships and obtaining foreign concessions which continued import would impose. In addition, there is a good prospect that part of the development so made would represent a permanent domestic industry.